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Lim et al.

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(54) **POWER TOOL**

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(51) **Int. Cl.**

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B25C 5/15	(2006.01)
B25C 5/16	(2006.01)
B25C 1/00	(2006.01)

(52) **U.S. Cl.**

CPC ***B25C 1/003*** (2013.01); ***B25C 1/06*** (2013.01); ***B25C 5/15*** (2013.01); ***B25C 5/1617*** (2013.01); *B25C 1/008* (2013.01)

(58) **Field of Classification Search**

CPC B25C 1/06; B25C 1/001–005; B25C 5/15; B25C 5/1617; B25C 5/162

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,604,220	A *	10/1926	Davis	B25C 1/06 227/116
2,572,012	A *	10/1951	Curtis	B25C 1/001 227/137
7,866,521	B2	1/2011	Gross et al.	
8,162,073	B2 *	4/2012	Krondorfer	B25C 1/06 173/1
8,636,185	B2 *	1/2014	Largo	B25C 1/005 227/136
9,744,657	B2	8/2017	Baron et al.	
10,693,344	B2	6/2020	Purohit et al.	
D911,803	S	3/2021	Kirkpatrick et al.	
10,933,521	B2 *	3/2021	Ferris	G01R 19/15
11,224,960	B2 *	1/2022	Garces	B25C 1/047

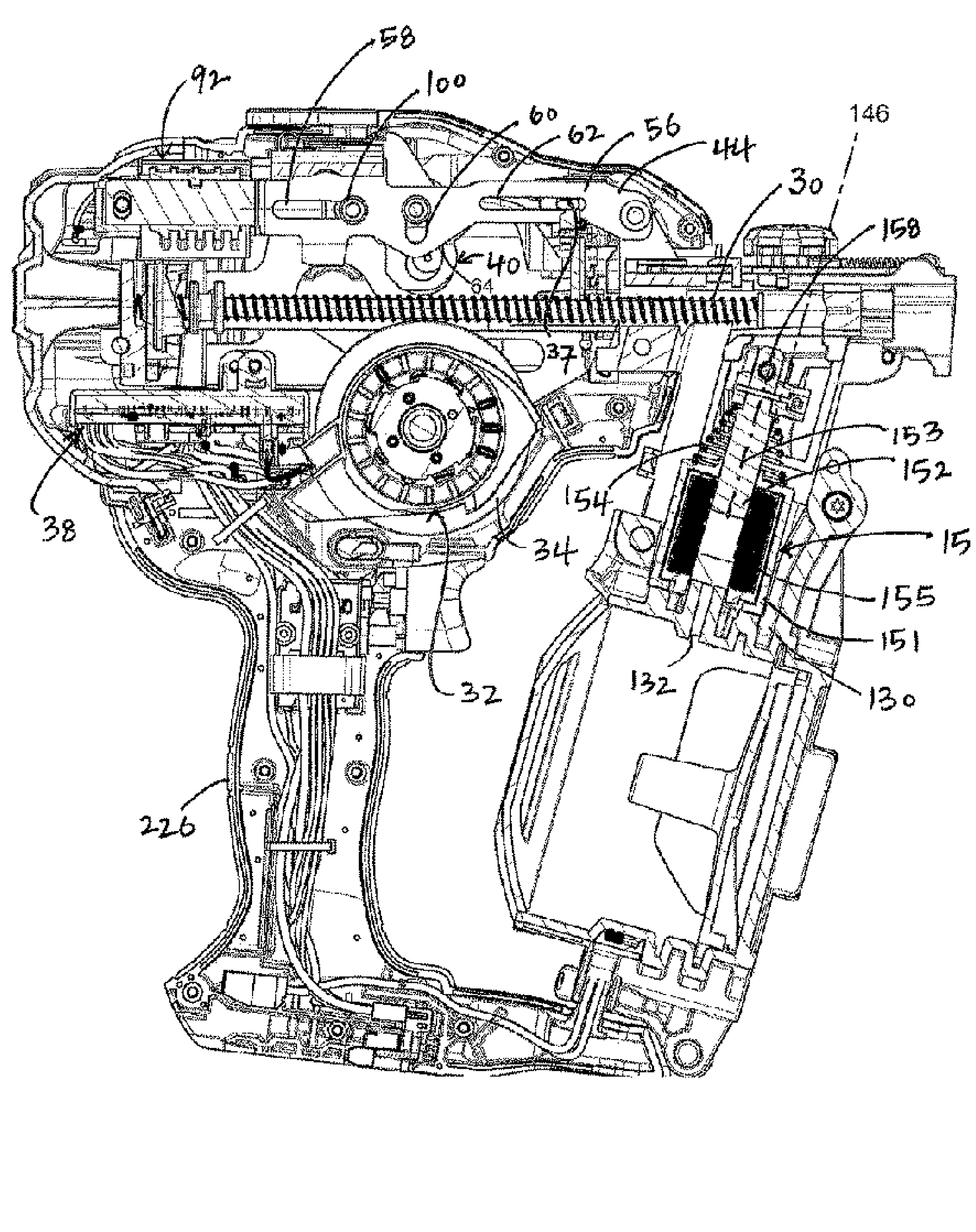
(Continued)

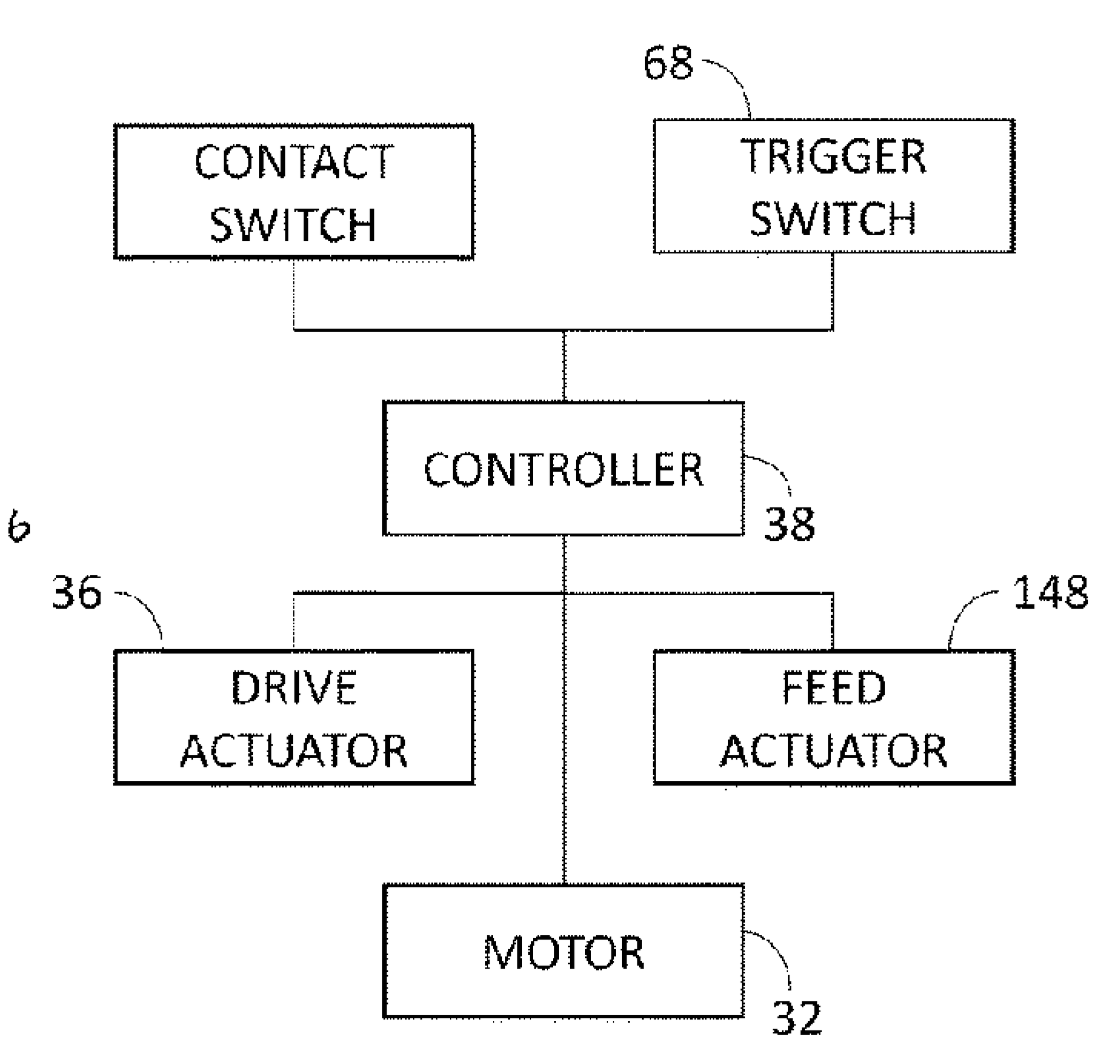
Primary Examiner — Joshua G Kotis

(57) **ABSTRACT**

A tool is provided for applying fasteners to a workpiece. The tool has a housing with a nosepiece, a motor, a drive actuator, a magazine assembly that holds fasteners, and a feed assembly with a feed actuator configured to move a lead fastener into the nosepiece. A driver in the housing is driven by a drive system that is associated with the driver actuator. A controller is connected to the feed actuator and the drive actuator to implement a firing sequence for driving each lead fastener into the workpiece using the driver and feeding the lead fastener into the nosepiece assembly. The actuators may be in the form of solenoids. The controller is designed to energize and deenergize the motor selectively while the drive actuator and feed actuator are activated.

15 Claims, 16 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

11,370,095	B2 *	6/2022	Chien	B25C 1/06
11,498,195	B2 *	11/2022	Akiba	B25F 5/02
2013/0320066	A1	12/2013	Gregory et al.	
2014/0076951	A1 *	3/2014	Brendel	B25C 1/06 227/8
2018/0243889	A1	8/2018	Myers et al.	
2020/0039044	A1 *	2/2020	Akiba	B25C 1/06
2020/0189080	A1 *	6/2020	Aizawa	B25C 1/047
2020/0306941	A1 *	10/2020	Akiba	B25C 1/04
2022/0040836	A1 *	2/2022	Chien	B25C 1/005
2022/0347826	A1 *	11/2022	Schroeder	B25C 1/06

* cited by examiner

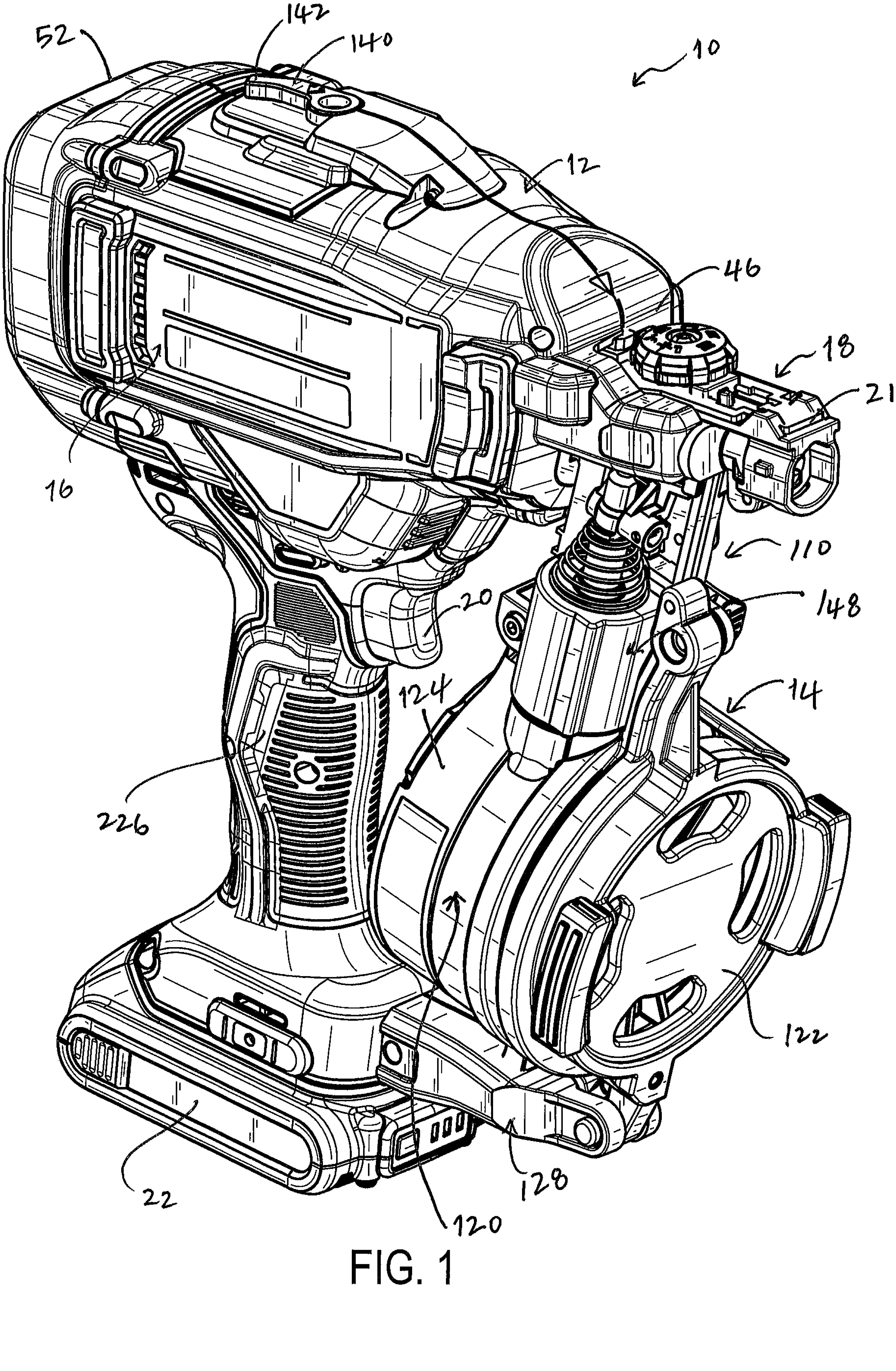


FIG. 1

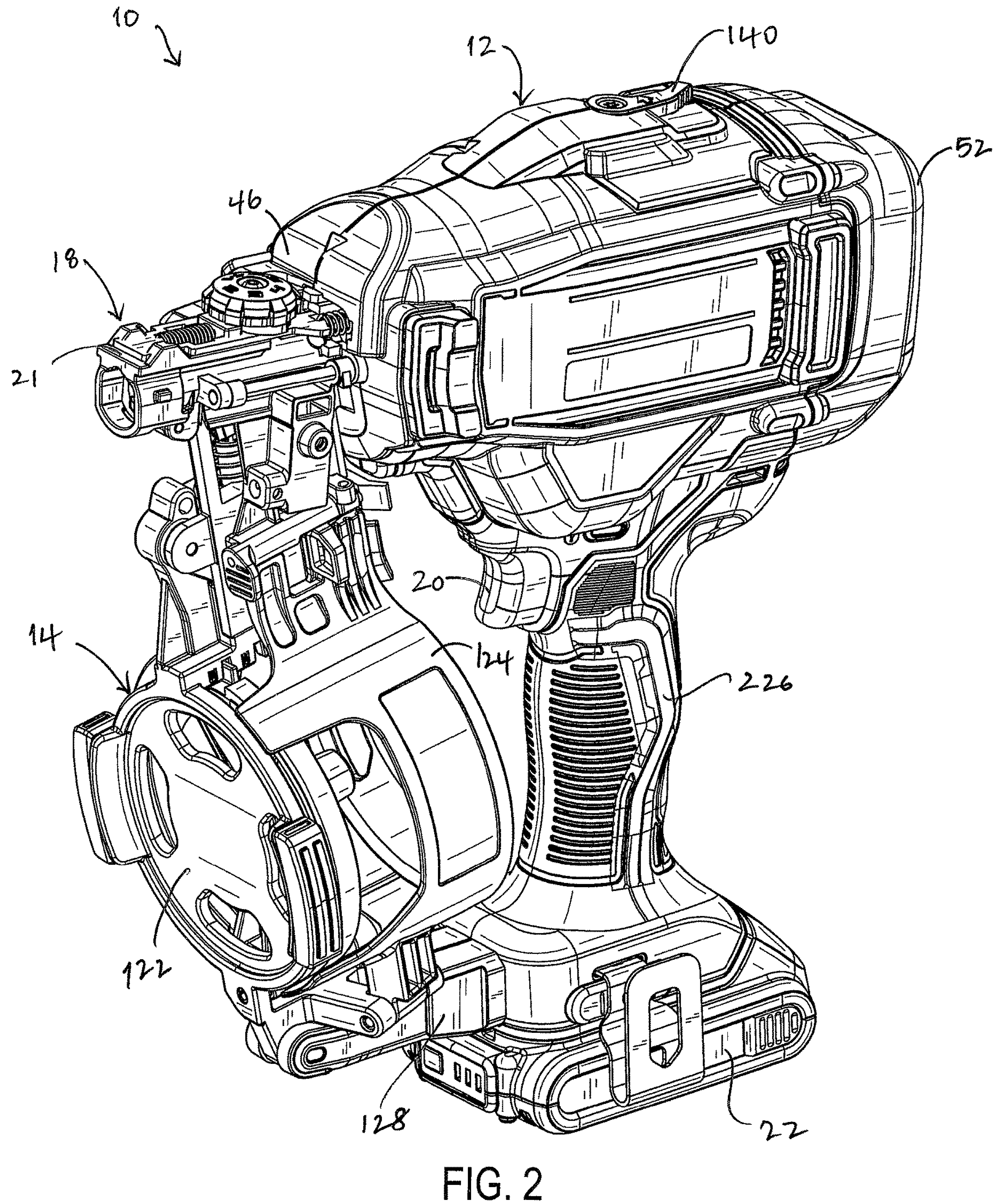


FIG. 2

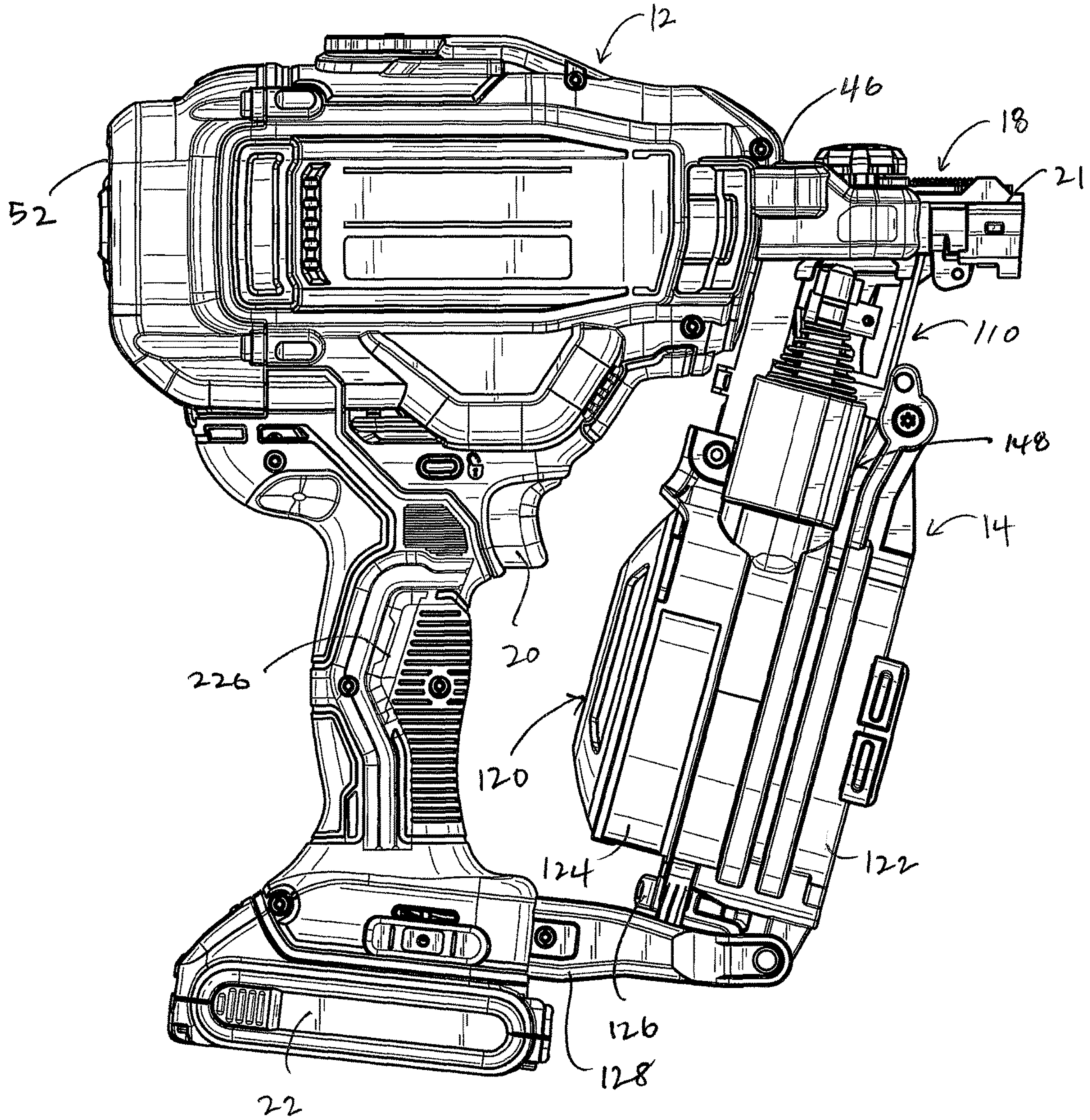


FIG. 3

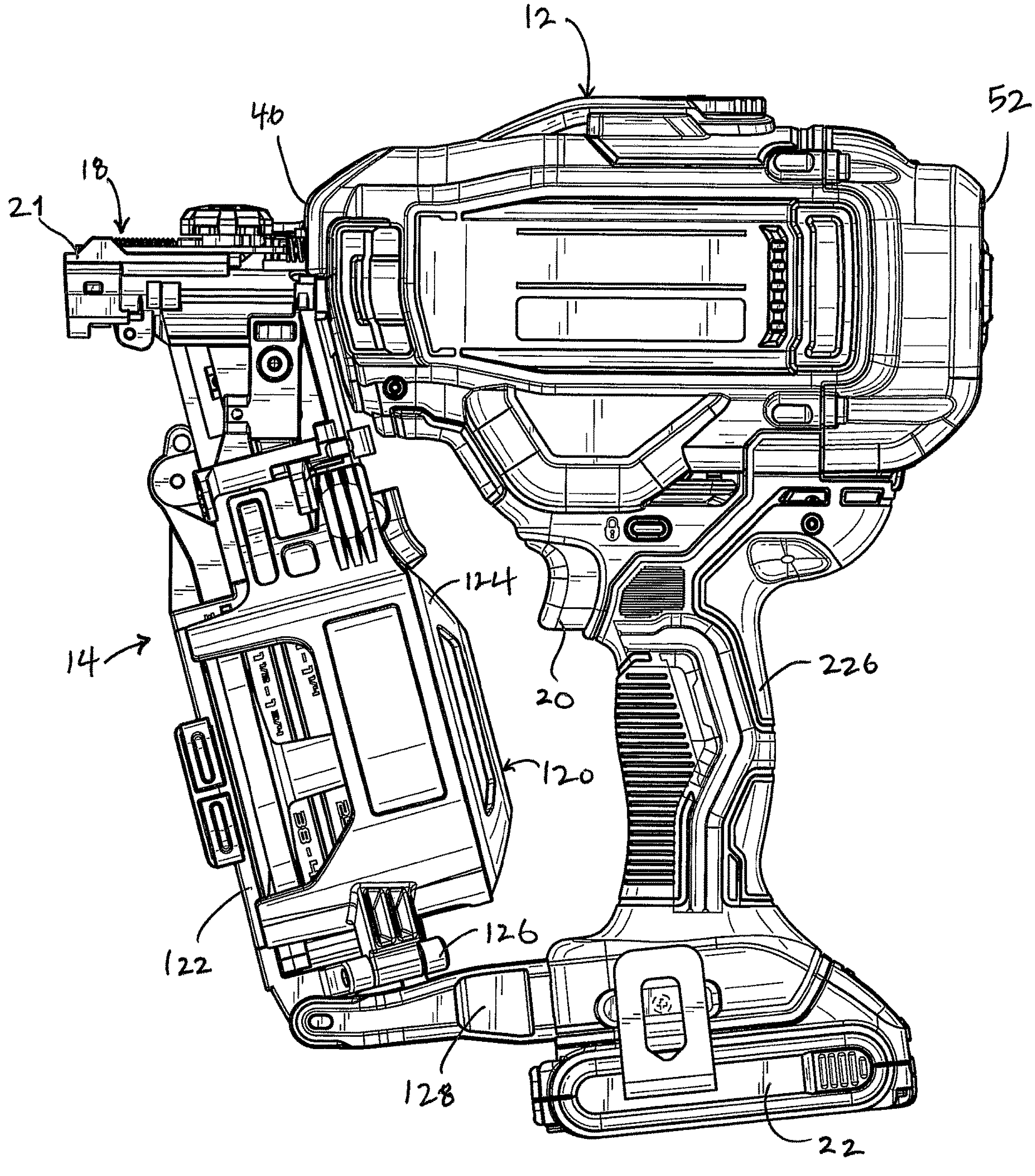


FIG. 4

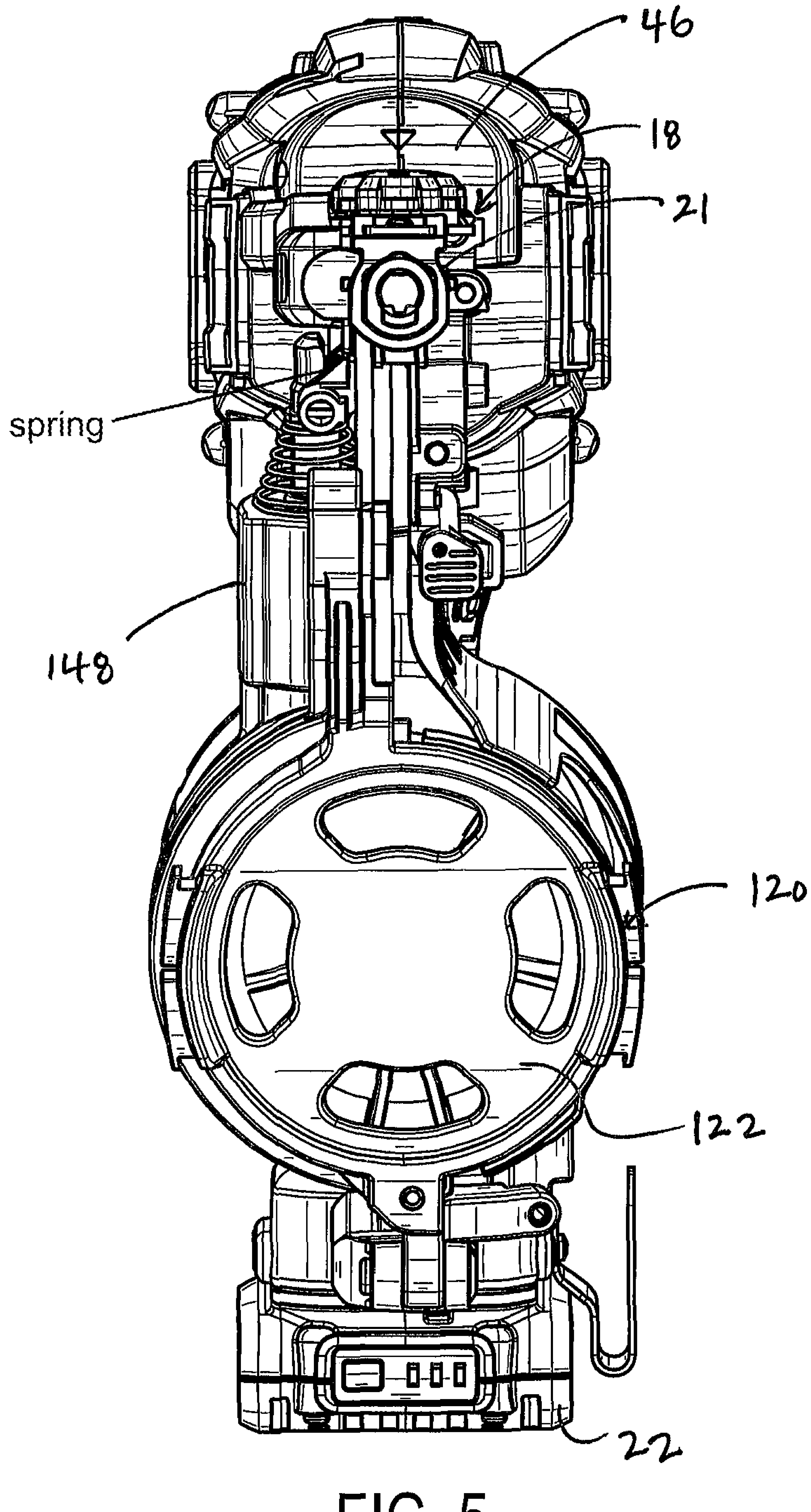


FIG. 5

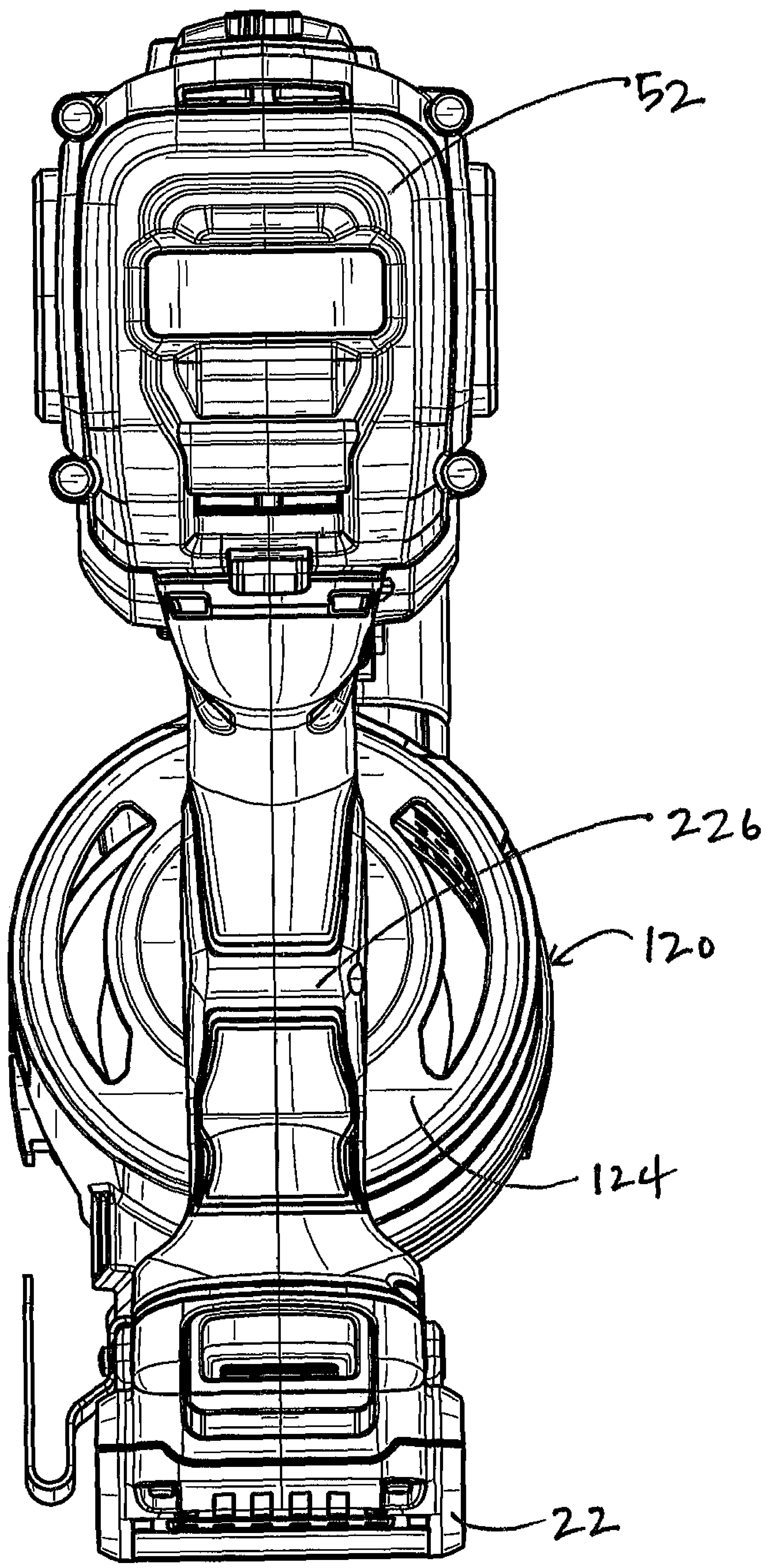


FIG. 6

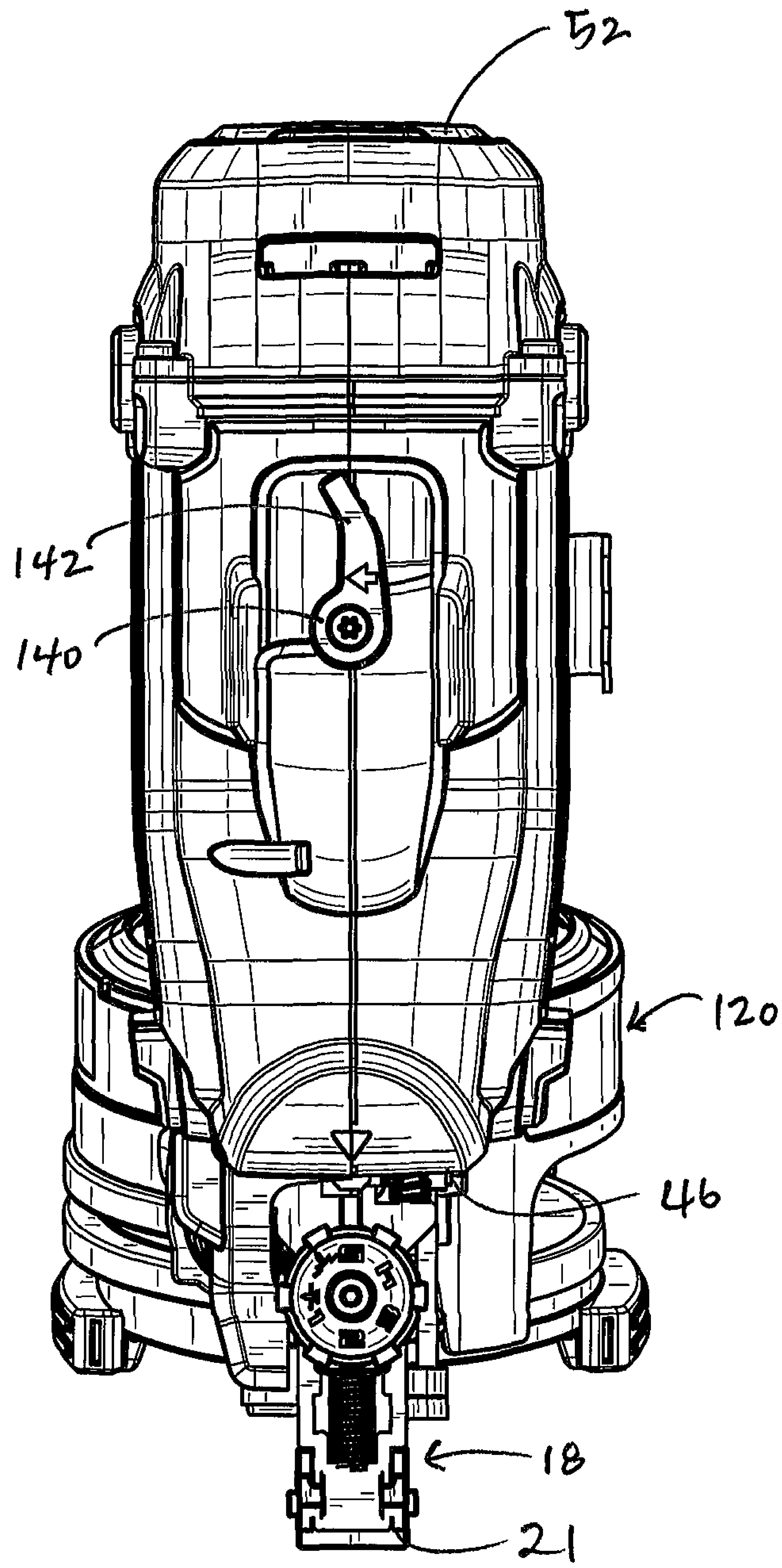


FIG. 7

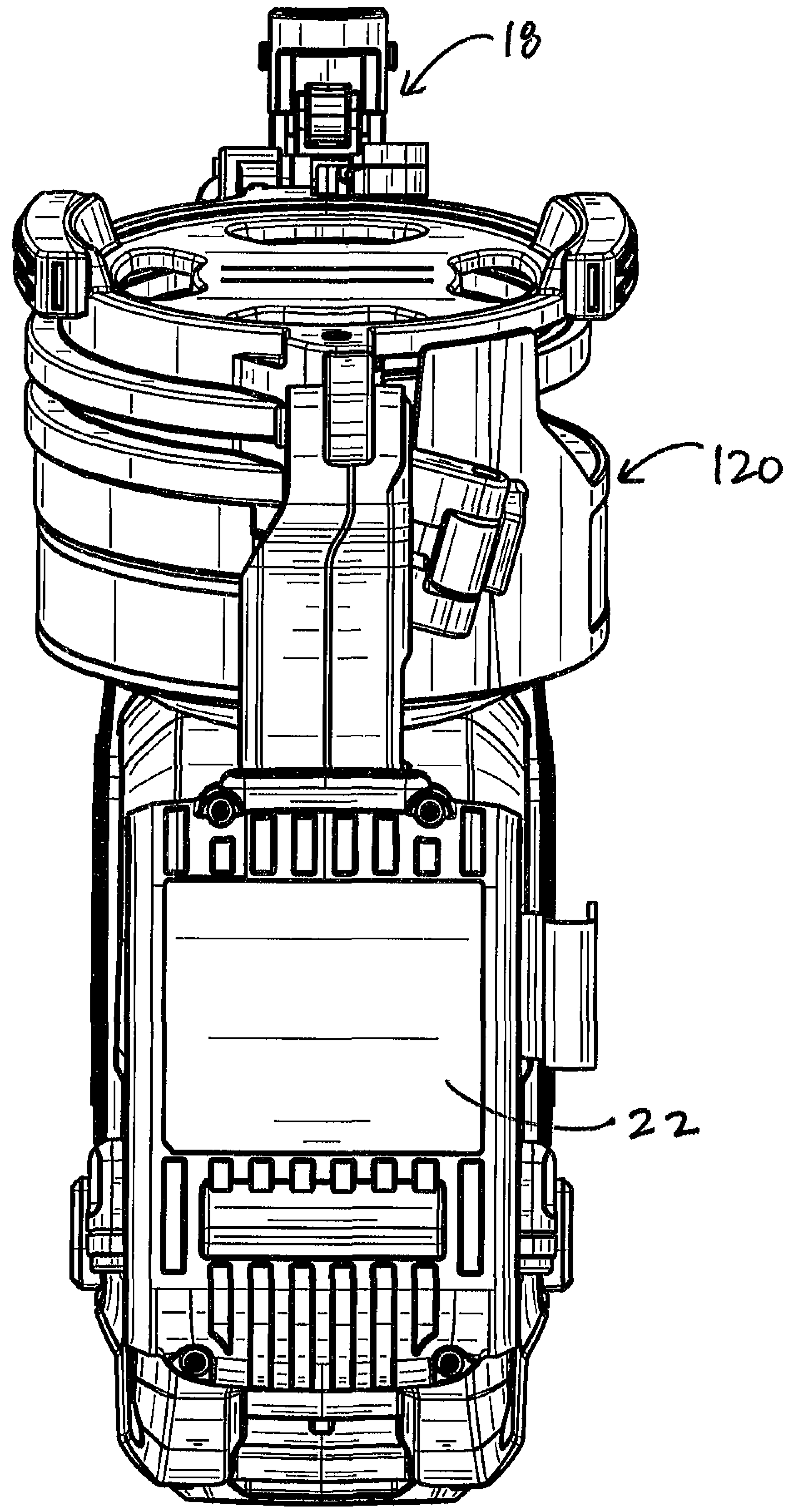


FIG. 8

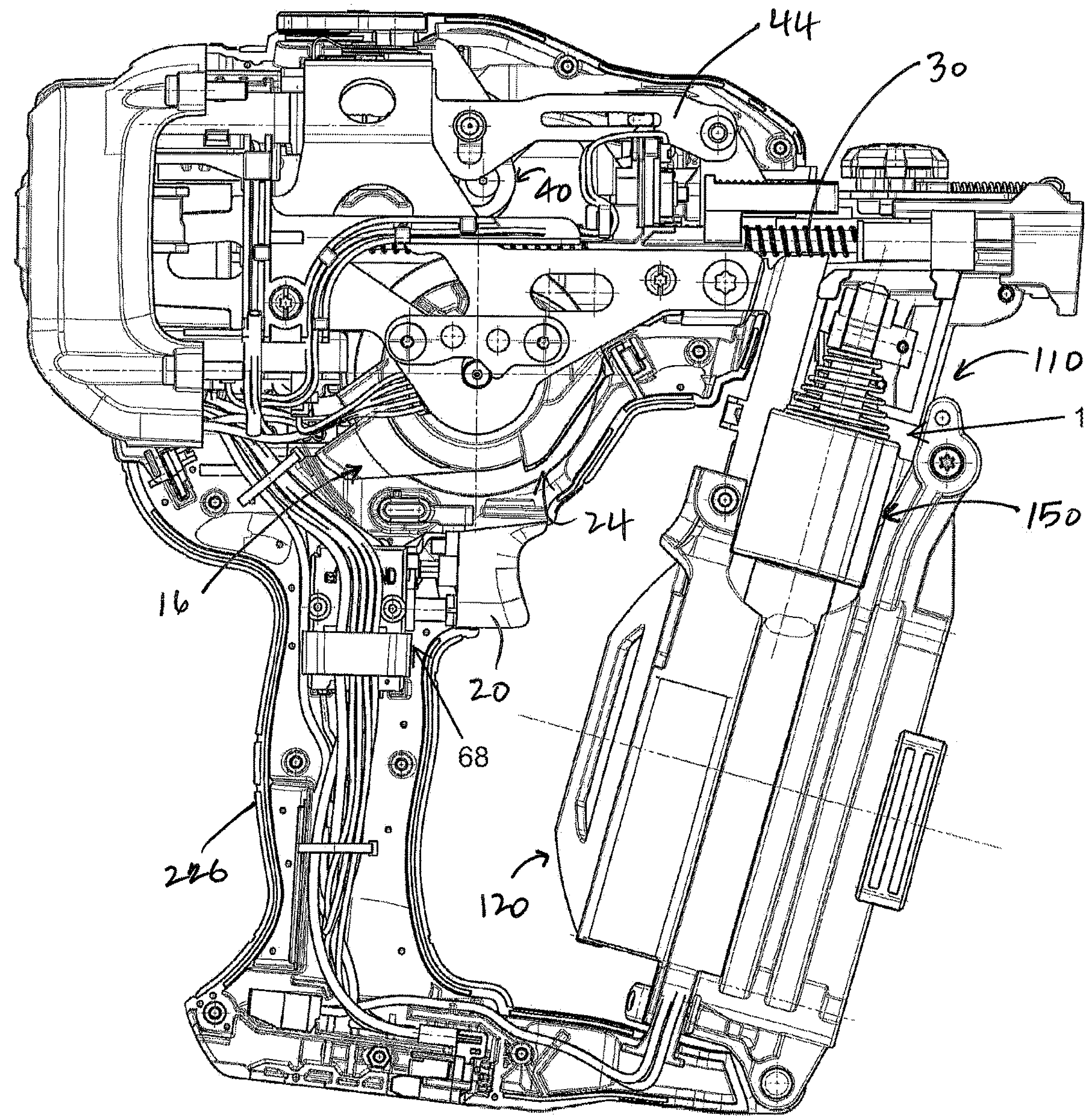


FIG. 9

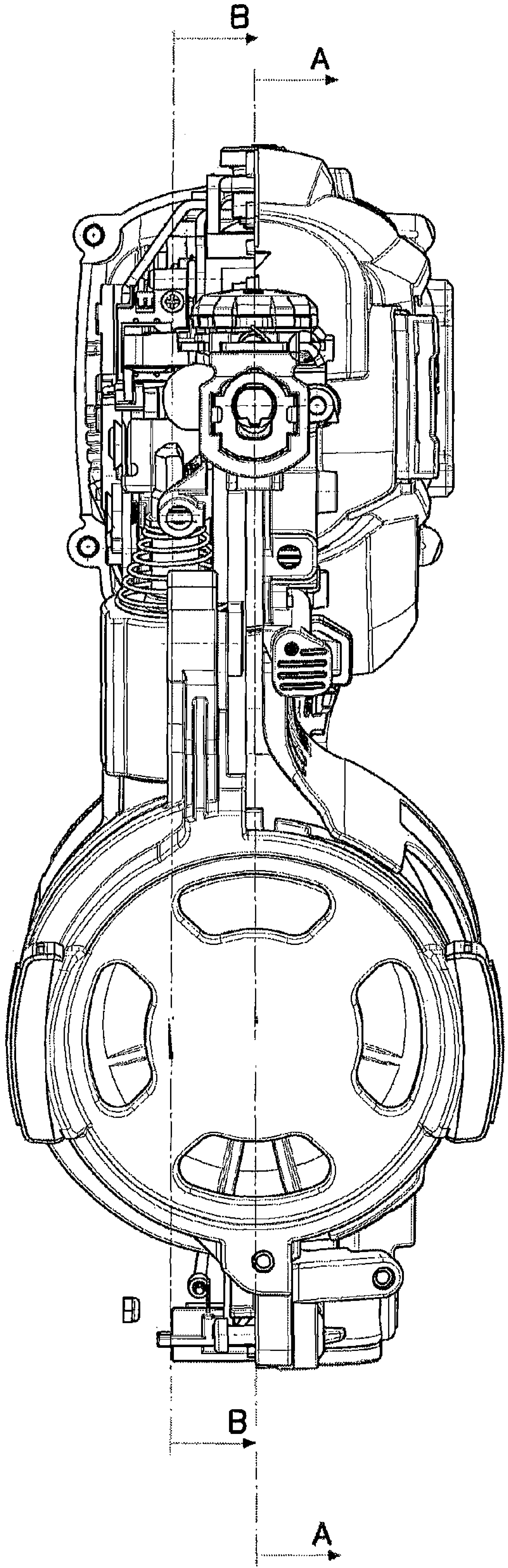
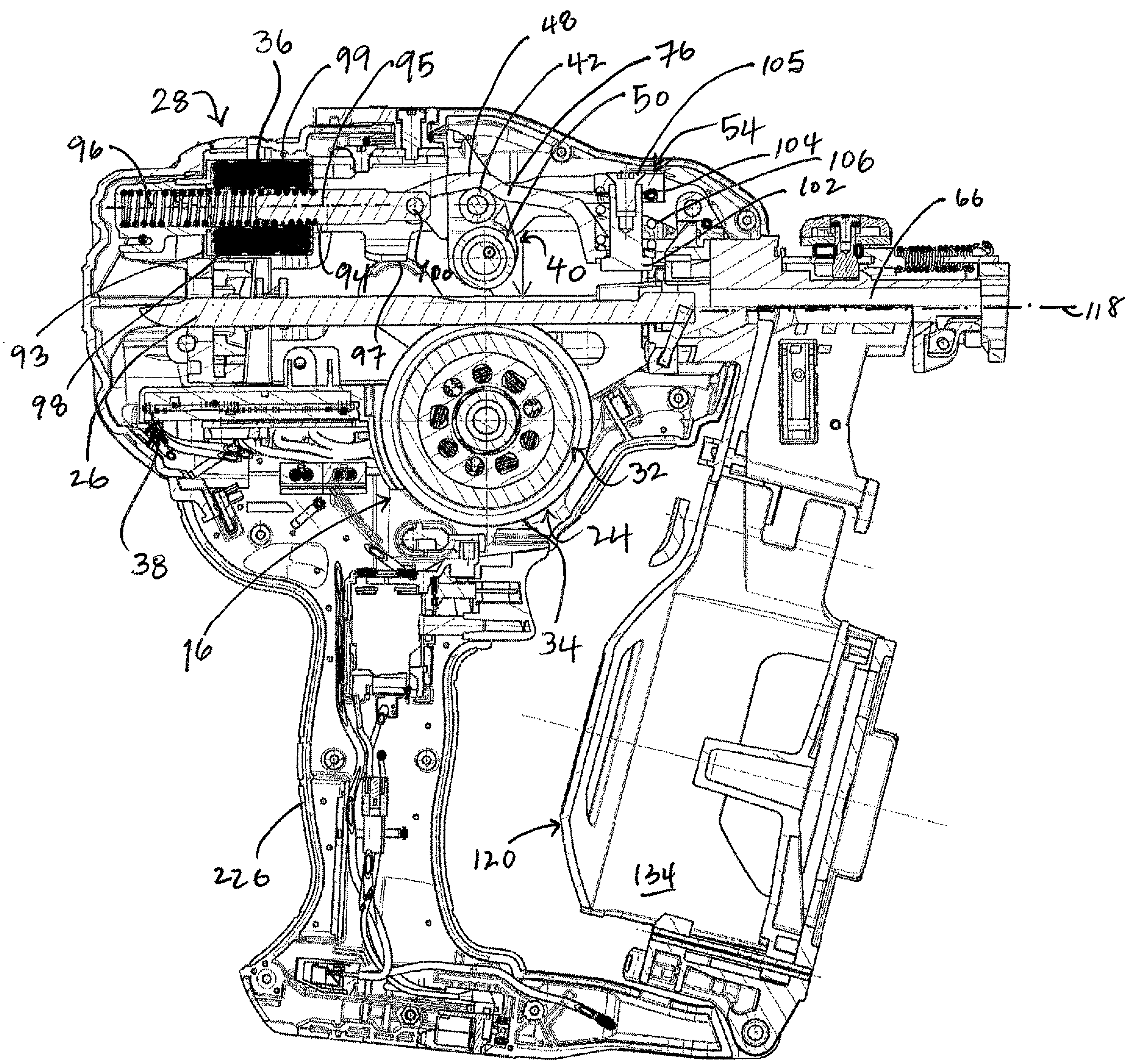


FIG. 10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26
38
32
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34
16
226
120
134

FIG. 11

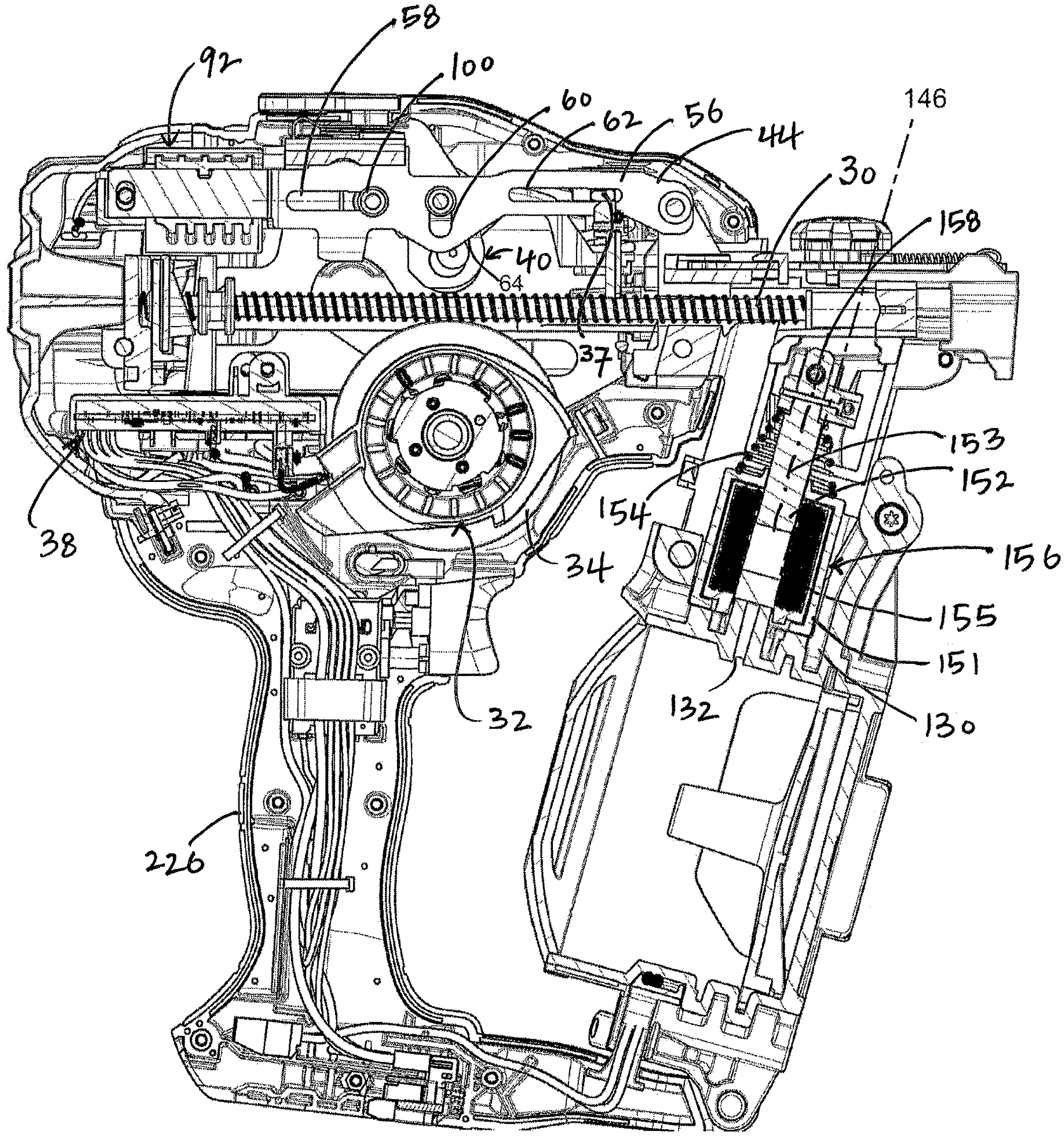
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FIG. 12

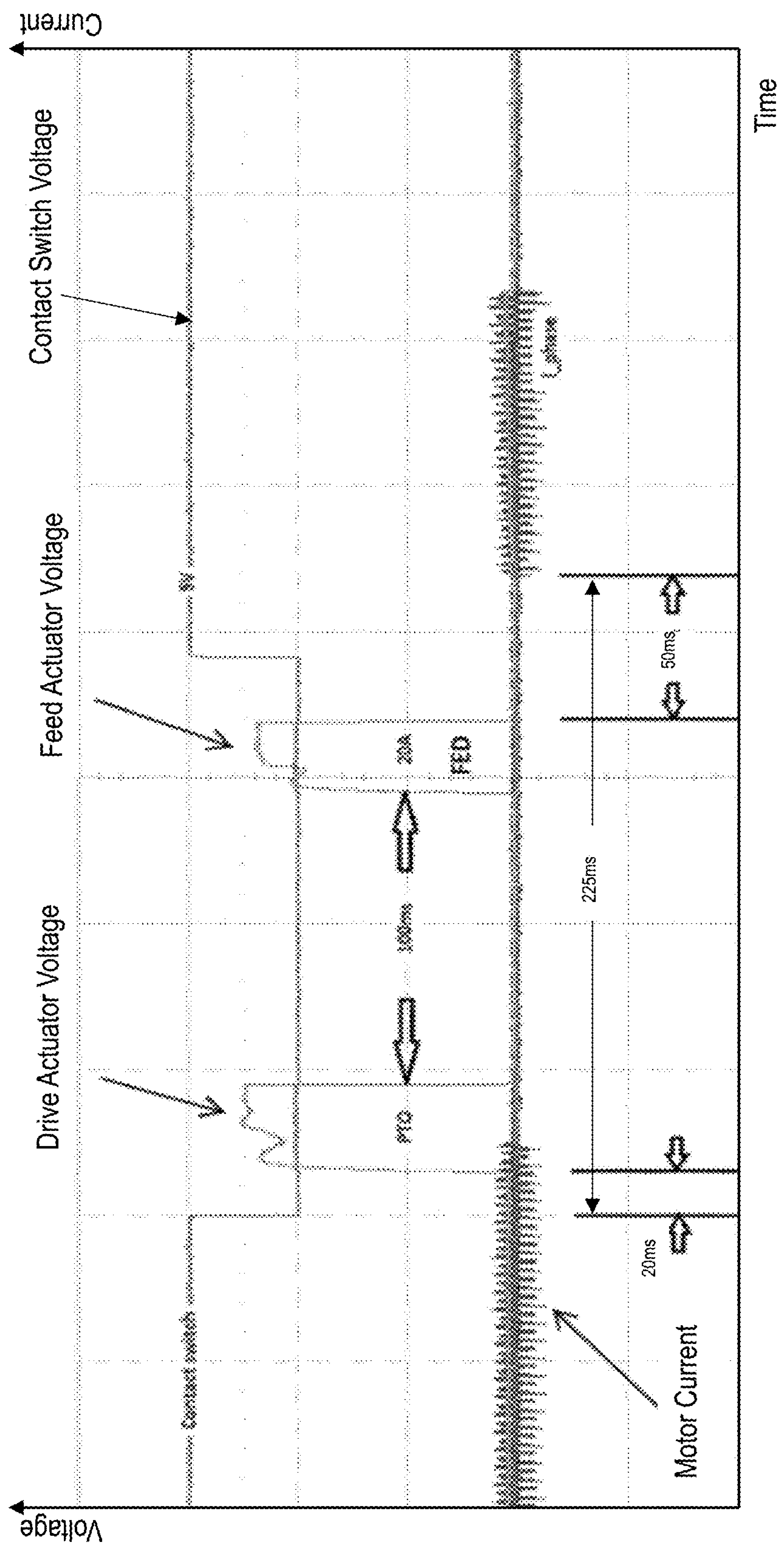
Current
Time
Voltage
Contact Switch Voltage
Feed Actuator Voltage
Drive Actuator Voltage
Motor Current
FED
225ms
50ms
20ms

FIG. 13

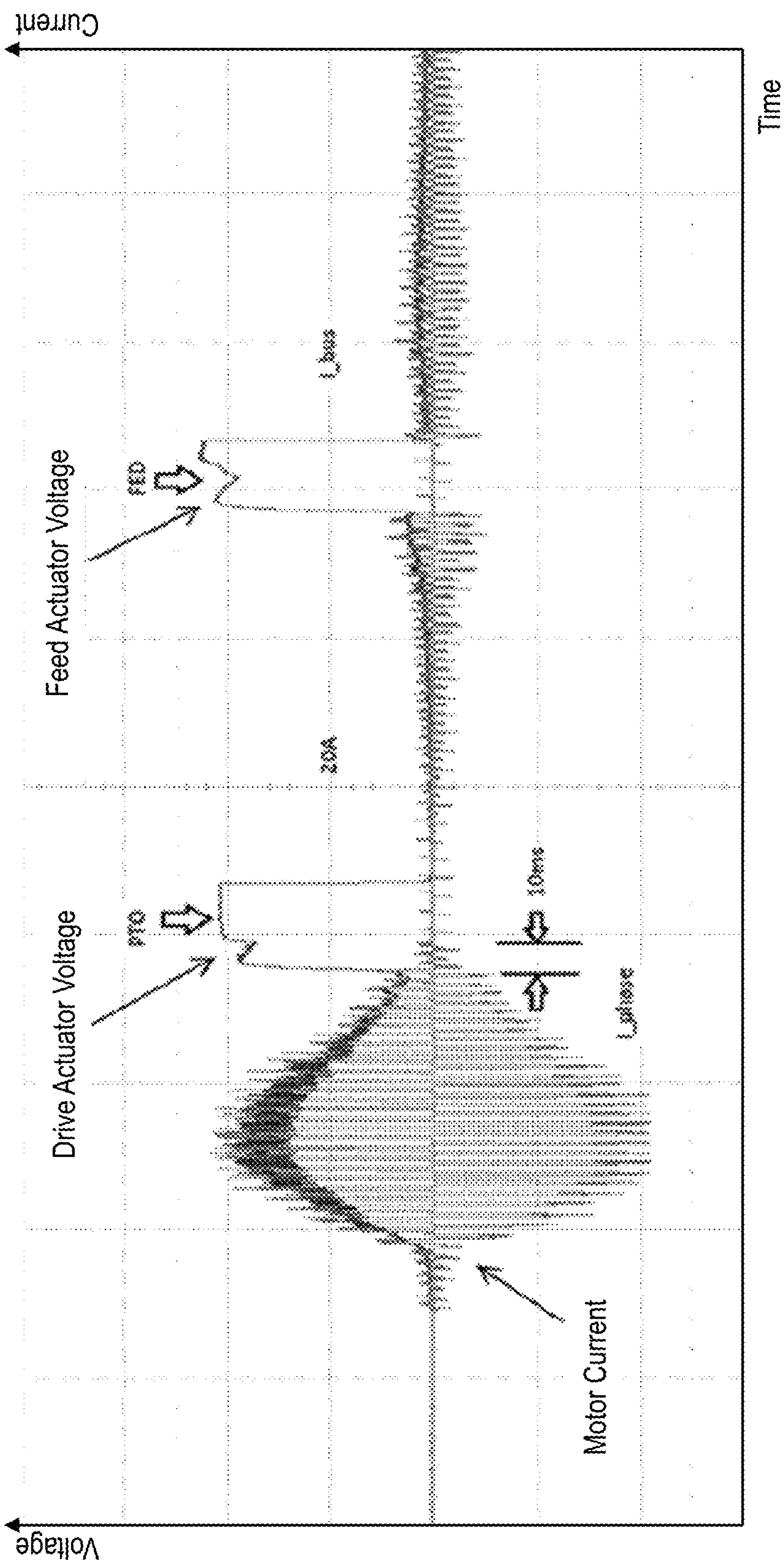
Current
Time
Voltage
Feed Actuator Voltage
Drive Actuator Voltage
Motor Current

FIG. 14

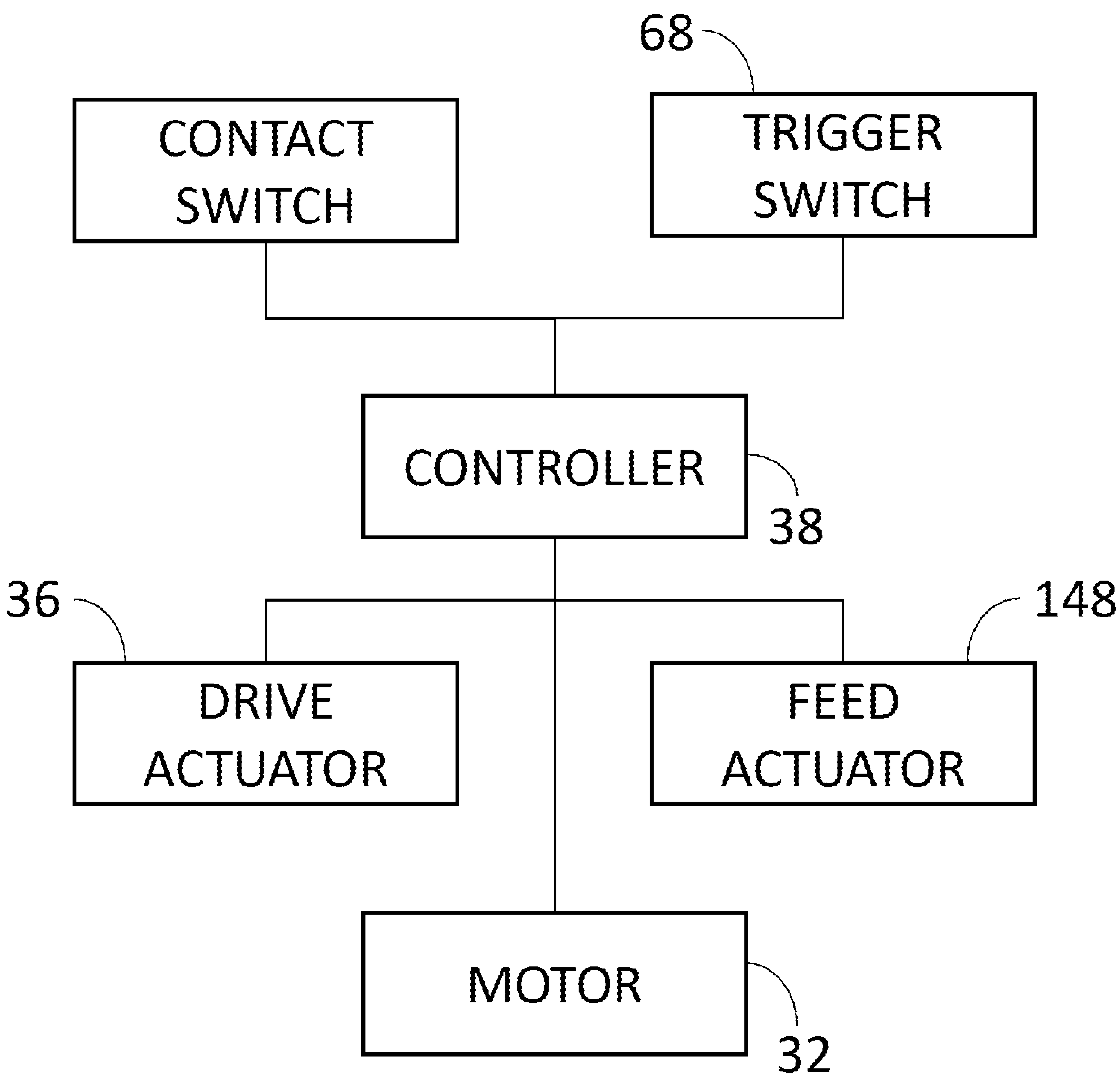
68
CONTACT SWITCH
TRIGGER SWITCH
CONTROLLER
38
36
148
DRIVE ACTUATOR
FEED ACTUATOR
MOTOR
32

FIG. 15

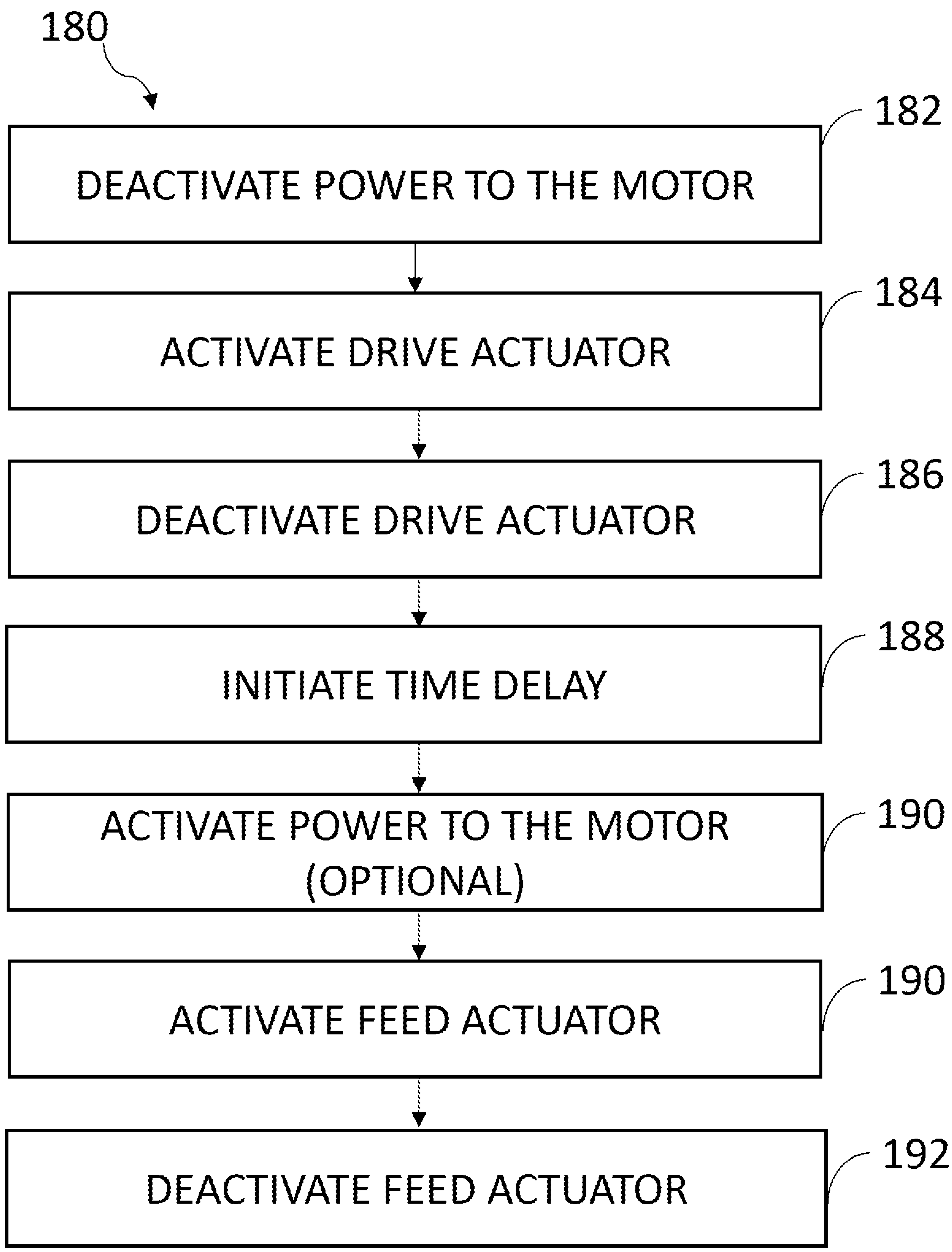
180
DEACTIVATE POWER TO THE MOTOR
182
ACTIVATE DRIVE ACTUATOR
184
DEACTIVATE DRIVE ACTUATOR
186
INITIATE TIME DELAY
188
ACTIVATE POWER TO THE MOTOR (OPTIONAL)
190
ACTIVATE FEED ACTUATOR
190
DEACTIVATE FEED ACTUATOR
192

FIG. 16

POWER TOOL

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 63/118,177, filed Nov. 25, 2020, and is related to U.S. Design patent application No. 29/694,590, filed Jun. 12, 2019, now U.S. Pat. No. D911,803, the entire contents of each of which are hereby incorporated by reference herein in their entireties.

FIELD

This disclosure relates, in general, to the field of power tools. In particular, the disclosure relates to portable fastening or driving tools, such as a nailers and staplers, and more particularly to improvements in such tools by using multiple actuators for driving a fastener into a workpiece.

DESCRIPTION OF RELATED ART

Fastening tools, such as power nailers and staplers, are relatively common place in the construction trades. Several types of cordless nailers have been introduced to the market in an effort to satisfy the demands of modern consumers. Some of the cordless nailers use a spring-loaded device to push fasteners into position such that a drive mechanism may then be actuated to fire or push a fastener into a workpiece.

Coil nailers, which typically include a drum for storing a coil of collated fasteners and a feed mechanism for feeding the fasteners into nosepiece of the fastening tool, are known in the art for attaching a series or a succession of nails or fasteners into workpieces.

Yet the coordinated driving and feeding of fasteners may be improved.

SUMMARY

It is an aspect of this disclosure to provide a tool including: a housing having a nosepiece assembly; a motor; a drive actuator; and a magazine assembly configured to hold a plurality of fasteners. A feed assembly is associated with the magazine assembly that is configured to advance the fasteners in a feed direction to present a lead fastener into the nosepiece assembly. The feed assembly has feed actuator configured to move said lead fastener into the nosepiece assembly. The tool also includes a driver provided in the housing that is configured for translational movement within a drive channel along a drive axis to drive the lead fastener into a workpiece. A drive system, associated with the drive actuator, is configured to selectively drive the driver along the drive axis. Also, the tool has a controller connected to the feed actuator and the drive actuator to implement a firing sequence for driving each lead fastener into the workpiece using the driver and feeding the lead fastener into the nosepiece assembly. The firing sequence implemented by the controller includes sending a first electric pulse to the drive actuator and a second electric pulse to the feed actuator. The motor is activated for at least a portion of a time between the first electric pulse and the second electric pulse.

Another aspect of this disclosure provides a method for operating the tool. For example, the method may include deactivating power to the motor; activating the drive actuator to thereby cause the translational movement of the driver

thus drive the lead fastener into the workpiece; and activating the feed actuator to feed the lead fastener into the nosepiece assembly. In an embodiment, a time delay is provided before activating the feed actuator. In one embodiment, the motor is deactivated for at least a part of each of the first and second electric pulses sent to activate the drive actuator and the feed actuator.

Other aspects, features, and advantages of the present disclosure will become apparent from the following detailed description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The numerous advantages of this disclosure may be better understood by those skilled in the art by reference to the accompanying Figures. In the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** illustrates a top and right-side perspective view of a cordless power tool in accordance with an embodiment.

FIG. **2** illustrates a top and left-side perspective view of the tool of FIG. **1**.

FIG. **3** illustrates a right-side elevation view of the tool of FIG. **1**.

FIG. **4** illustrates a left-side elevation view of the tool of FIG. **1**.

FIG. **5** illustrates a front elevation view of the tool of FIG. **1**.

FIG. **6** illustrates a rear elevation view of the tool of FIG. **1**.

FIG. **7** illustrates a top plan view of the tool of FIG. **1**.

FIG. **8** illustrates bottom plan view of the tool of FIG. **1**.

FIG. **9** illustrates a front view of the tool of FIG. **1**, with a portion of the housing removed to illustrate internal mechanisms therein.

FIG. **10** illustrates a front elevation view of the tool as shown in FIG. **9**.

FIG. **11** is a cross-sectional view along line A-A of the tool in FIG. **10** showing features of a drive actuator and drive system, in accordance with an embodiment herein.

FIG. **12** is a cross-sectional view along line B-B of the tool in FIG. **10** showing features of a feed actuator and a feed system, in accordance with an embodiment herein.

FIG. **13** illustrates a first excitation pattern for a firing sequence that is implemented by the tool, in accordance with an embodiment.

FIG. **14** illustrates a second excitation pattern for a firing sequence that is implemented by the tool, in accordance with another embodiment.

FIG. **15** illustrates a schematic representation showing electrical connections between the controller and drive and feed actuators, as well as some of the switches and motor included in the tool, in accordance with an embodiment.

FIG. **16** shows steps of a method for operating the tool, in accordance with an embodiment, using the controller.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

This disclosure relates, in general, to the field of power tools. For example, this disclosure relates to cordless, portable driving tools, such as a nailers and staplers, and improvements made therein to both driving capabilities and feeding features associated therewith. In particular, the tool includes two actuators—one for driving a fastener, another for feeding the fastener—which are controlled by a power control module, along with a motor, in order to drive and load fasteners in succession and, in some cases, ready the tool such that shot-to-shot time of fasteners is increased.

In accordance with an embodiment, the drive actuator, the driver, and the drive system used in the tool and described below may be an electrical actuator, drive, and drive system as described in U.S. Pat. No. 9,744,657, which is incorporated by reference herein in its entirety. In accordance with an embodiment, the feed actuator, the magazine assembly used in the tool and as described below, and the feed assembly used in the tool may be an electrical actuator, magazine assembly, and feeder assembly as described in U.S. Pat. No. 7,866,521, which is incorporated by reference herein in its entirety. For example, the feed assembly and feed actuator as shown in the Figures may be an automatic coil feeder assembly as shown in FIGS. 25-27 of the incorporated '521 patent.

FIGS. **1-12** illustrates an embodiment of a fastener driving tool **10** (i.e., "tool") that is adapted to drive fasteners into a workpiece. The fasteners may be U-shaped staples, brads, nails, and the like. In an embodiment, the fasteners may be collated. The tool **10** may be a cordless power tool, in accordance with an embodiment. In one exemplary embodiment, the tool **10** is a nailer or nail gun configured to drive nails into a workpiece.

The tool **10** includes a housing assembly (or housing) **12** that has a nosepiece assembly **18**; a motor **32** that is part of a drive system **16** (or drive motor assembly) and a power source **24**; and a magazine assembly **14** configured to hold a plurality of fasteners coupled to the housing assembly **12**. The magazine assembly **14** may be provided such that it extends between the nosepiece assembly **18** and a base portion of the tool (e.g., near a removable battery pack **22**), in accordance with an embodiment. The housing assembly **12** has a front end **46** and a back end **52**. The housing assembly **12** may include a handle **226** adapted to be gripped by the hand of an operator or user. In an embodiment, the handle **226** extends between a top end and a bottom end of the housing assembly **12**. In an embodiment, the housing assembly **12** may be formed from molded parts. As generally represented in FIGS. **1**, **5**, and **10**, for example, in one embodiment, a first side part and a second side part of the housing assembly **12** may be molded and joined together to encapsulate parts of the fastener driving and feed mechanisms (described in greater detail later) within the housing **12**. The housing assembly **12** may be made of extruded or molded plastic, for example. In one embodiment, the housing **12** may be formed from an Acrylonitrile Butadiene Styrene (ABS) plastic. Of course, other materials, such as polycarbonates and/or combinations of materials, may also be used to form the housing **12**, and thus these examples should not be limiting.

The housing assembly **12** may include a trigger **20**, adjacent to or on the handle **226**, which is connected to a power control module **38** (also referred to in this disclosure as a control unit or controller). The trigger **20** may be provided in the form of a button for manual operation such that when an operator grips the handle **226**, the trigger **20** may be engaged by a forefinger of the operator. The trigger **20** is mechanically coupled to the handle **226** and electrically coupled to at least the motor **32** and control module **38** (or controller) such that electric power may be selectively provided thereto, such as schematically shown in FIG. **15**. The trigger **20** may be a push button that moves back and forth, or a button that may be pivotally mounted to the housing assembly **12** by way of a pivot, such that application of force via the operator's forefinger moves the trigger **20** relative to the handle **226**. The trigger **20** may be associated with a trigger switch **68** (see FIG. **9**), a contact trip assembly **21**, and control module **38** (see FIG. **11**). The contact trip assembly **21** acts as a safety mechanism to prevent accidental activation of the tool **10**. Generally, an operator of the tool **10** may hold or grip the tool **10** by providing their hand around the handle **226** and place the nosepiece assembly **18** at a desired location for applying a fastener, push down on the contact trip assembly **21**, and depress the trigger **20** in order to activate the control module **38** and the internal actuators (as described later) and cause a fastener to be ejected at that desired location. In an optional embodiment, a contact trip assembly **21** may be provided on the nosepiece assembly **18**. The contact trip assembly **21** may act as a safety device for the tool **10**, such that the safety device must first be deactivated in order to propel the driver **26** and drive a fastener into the workpiece. Other safety devices (e.g., mechanical and/or electrical, like switches) may also be provided in the tool **10**. In an embodiment, the contact trip assembly **21** includes a contact trip (or contact trip member) actuatable to initiate the drive stroke. The contact trip may be positioned in front of the driver **26** (such as shown in FIG. **11**) in the housing **12** of tool **10**. The contact trip is configured for movement relative to the housing assembly **12** parallel to the movement of the driver **26**. Also provided are a contact trip spring and a contact trip switch. The contact trip switch is configured such that the switch may be tripped or actuated (e.g., closed) to allow use of the tool **10** (when all conditions are met for driving or firing), and may also be electrically coupled to the controller (such as shown in FIG. **15**). The contact trip switch may be provided in a normally open position and closed when the contact trip spring is compressed by force upon the contact trip itself, for example. In an exemplary embodiment, as an operator applies force or bias on the tool **10**, i.e., towards a workpiece, a contact surface of the contact trip assembly **21** engages the workpiece and then actuates movement of the body of the contact trip relative to the drive channel, thereby closing a trip switch and spring-loading or compressing the contact trip spring which normally biases the contact trip assembly **21** relatively forward (e.g., to the right as shown in FIG. **11**) such that the tool is disabled from firing. When the trigger **20** is actuated by the operator's forefinger (e.g., the trigger switch **68** is closed) and all other conditions for firing are met, the drive system **16** and thus the motor **32** may be initiated i.e., activated or energized, to fire a fastener. Such features are known in the art and thus not further described here.

In addition to the contact trip assembly **21**, the nosepiece assembly **18** may include a barrel **66** (see FIG. **11**) which forms a part of the drive channel for the driver **26** to move within an interior portion thereof and drive a fastener. In accordance with an embodiment, the nosepiece assembly **18** used in the tool may include one, some, or all features as described in U.S. Publication No. 20130320066 and/or U.S. Publication No. 20180243889, both of which are incorporated by reference herein in their entireties.

The magazine assembly **14** is an elongated receptacle that extends away from the nosepiece assembly **18**, towards a back end of the handle **226**. In an embodiment, the magazine assembly **14** may be positioned an acute angle relative to the handle **226** and extending between the nosepiece assembly **18** and a bottom portion of the handle **226**, such that a bottom portion (i.e., a bottom of the canister **120**) of the magazine assembly **14** may be positioned at an acute angle relative to a workpiece W when the nosepiece assembly **18** is positioned and configured for applying the fastener thereto.

The magazine assembly **14** holds a plurality of fasteners or nails that are configured to be dispensed from the tool **10** with sufficient energy to penetrate a workpiece. As shown, the example fastener driving tool **10** is a battery-powered nailer with a battery pack **22** and the magazine assembly **14** is configured to hold collated nails. The magazine assembly **14** (via its parts therein) is generally configured to sequentially present a lead fastener of the plurality of fasteners into a drive channel of the tool **10**. As can be appreciated, the principles, technologies and structures described herein can also be used on other fastening devices including electric or pneumatic staplers, nailers, and the like. Further, the term "fastener" herein is intended to include staples, nails, and the like. In some instances throughout this disclosure, fastener and nail may be used interchangeably.

In accordance with a non-limiting embodiment, the magazine assembly **14** may include a canister **200** for holding coiled, collated nails and a feed mechanism or feed assembly **110**, which may include a feed pawl assembly (not shown) and a follower pawl assembly (not shown). In an embodiment, one or more teeth or guides may be provided as part of the feed assembly **110**. The canister **200** may include a first canister portion **212**, a second canister portion **214**, a hinge pin **216**, as well as a latch bracket and a canister latch. The first canister portion **212** may be fixedly coupled to the housing assembly **12**. In an embodiment, the first canister portion **212** includes a first mount **128** (see, e.g., FIG. **3**, which may be fixedly but removably coupled to a handle **226** of the housing assembly **12** via a threaded fastener, and a second mount **130** (see, e.g., FIG. **12**), which may be fit over a portion of the feed assembly **110**. A vent hole **132** (shown in FIG. **12**) may be formed in the second mount **130** to permit air to enter or exit an open end in the feed assembly **110**.

The second canister portion **214**, which may be formed of an appropriate plastic material, may be pivotally coupled to the first canister portion **212** so that the second canister portion **214** may be moved between a first position, which may substantially close an interior portion **134** (see FIG. **11**) of the canister **200**, and a second position, which may generally clear the first canister portion **212** so that coiled, collated nails may be loaded into the interior portion **134** of the canister **200**. The aforementioned canister latch may be actuated so that the second canister portion **214** may be rotated about the hinge pin **216** to expose an interior portion of the canister **200** for its loading. A coil of the collated fasteners may be inserted into the canister **200** and an end of the collated fasteners with a lead fastener may be strung towards the drive channel or barrel **66** such that one of the collated fasteners is positioned in the feed assembly **110** for feeding (e.g., using teeth and/or a pawl assembly, and feed actuator **148**, as described later).

In one embodiment, the bottom end of the housing may have a removable and rechargeable energy storage device, which may include a battery pack **22**. The battery pack **22** may configured to engage an end portion of the tool **10** and provide power to a motor **32** within the housing assembly **12**, such that the tool **10** may drive one or more fasteners which are fed from the magazine assembly **14** into a workpiece W. The location of the battery pack **22** as shown in the Figures is not limiting and is illustrative only; indeed, the battery pack can be located anywhere on the tool **10**. In addition, although the energy storage device is illustrated as being a battery pack, embodiments of this disclosure are not limited to battery packs being the energy storage device. That is, in some embodiments, the tool **10** may include a cord and a plug for plugging into a common household AC outlet.

While the fastening tool is illustrated as being electrically powered by a suitable power source or energy storage device, such as the battery pack **22**, those skilled in the art will appreciate that the disclosure, in its broader aspects, may apply to other powered fastening tools. Furthermore, while aspects of the disclosure are described herein and illustrated in the accompanying drawings in the context of a nailer, those of ordinary skill in the art will appreciate that the invention, in its broadest aspects, has further applicability. For example, the drive motor assembly may also be employed in various other mechanisms that use reciprocating motion, including rotary hammers, hole forming tools, such as punches, and riveting tools, such as those that install deformation rivets.

A drive system **16**, associated with a drive actuator **36**, is configured to selectively drive the driver **26** along a drive axis **118** (or path), to drive a nail or fastener. The drive system **16** (also referred to herein as a drive motor assembly), as shown in FIGS. **9** and **11-12**, may include a power source **24**, a driver **26** (see FIG. **11**), an activation arm assembly **28** (see FIG. **11**), and a return mechanism **30** (see FIGS. **9** and **12**), in accordance with an embodiment. In the exemplary illustration, the power source **24** includes a motor **32**, a flywheel **34**, and a drive actuator **36**, as shown in FIG. **11**. That is, in accordance with an embodiment, the motor **32** is an outer rotor brushless motor, wherein the rotor is provided on an outside and the stator is provided on an inside thereof.

In operation, fasteners are stored in the magazine assembly **14**, which sequentially feeds the fasteners into the nosepiece assembly **18**. The drive motor assembly **16** may be actuated/activated by the control module **38** to cause the driver **26** to translate and impact a lead fastener in the nosepiece assembly **18** (i.e., in the drive channel) so that the lead fastener may be driven into a workpiece (not shown). Actuation of the power source may utilize electrical energy from the battery pack **22** to operate the motor **32** and the drive actuator **36**. The motor **32** is employed to drive the flywheel **34**, while the drive actuator **36** is employed to move the (second) roller **50** that is associated with the roller assembly **40**, which squeezes the driver **26** into engagement with the (rotating) flywheel **34** so that energy may be transferred from the flywheel **34** to the driver **26**, to cause the driver **26** to translate. The nosepiece assembly **18** (and drive channel) guides the lead fastener as it is being driven into the workpiece. The return mechanism **30** biases the driver **26** back into a returned position. As seen in FIG. **12**, for example, the return mechanism **30** includes a biasing member, or spring, which is configured to push (e.g., backwards, or to the left in the figure) the driver **26** back and away from the nosepiece assembly **18** after the driver **26** is deployed to fire a fastener from the tool **10**.

As briefly noted above, the drive system **16** may include the activation arm assembly **28** that has at least one arm and at least one roller for moving the driver **26**. The arm may be spring biased by a spring towards a first position, and the drive actuator **36** may be configured to initiate movement of corresponding parts within the tool, to thereby press against the spring-bias and move the arm into a second position. As the arm moves, the roller(s) move to press against and push the driver **26** into engagement with the flywheel **34** to cause the translational movement of the driver **26**.

In accordance with an embodiment, the activation arm assembly **28** may include the drive actuator **36**, a carriage **44** (see FIG. **9**), a roller assembly carrier, a follower arm **48**, a roller assembly **40** that includes a first roller **42** and a second roller **50**, and a biasing mechanism **54**. While FIG. **9** only shows one side (e.g., right) of the tool and thus the carriage **44**, it should be understood that the carriage **44** may include a pair of arm members **56** (see FIG. **12**) that can be spaced laterally apart, one on each side of the tool **10**. Each arm member **56** can include an actuator slot **58**, a pivot slot **60**, a retainer aperture **62** and a notch (not shown) as depicted in FIG. **12**. The arm members **56** may have a first portion configured to retain the drive actuator **36** (or solenoid **92**, in accordance with one embodiment herein), and a second portion configured to retain the biasing mechanism **54** (shown in FIG. **11**). The carriage **44** can be fixedly but removably coupled to the backbone via a tab **37** on each side of a spring cap. The tab **37** can be received through the retainer aperture **62**.

As shown in FIG. **11**, the biasing mechanism **54** can include a first cap **102**, a second cap **104**, a fastener **105** and a spring **106**. The first cap **102** can have a generally cylindrical body member **108** and a flange that can be disposed about a body member which may be received in a hole in the first portion of the follower arm **48**. Such features are further described in the incorporated '657 reference and thus not detailed here.

As generally understood in the art and thus not described in detail herein, the aforementioned roller assembly carrier may include axle(s) which extend through the carriage **44** and are received in pivot slots **60** for rotation about the axle(s) and for movement relative to the carriage **44**. The first roller **42** (shown in FIG. **11**) may be rotatably mounted on a first axle and the second roller **50** may be rotatably mounted on a second axle. In the illustrated, the centerline of the second axle is relatively closer to the retainer aperture **62** (see FIG. **12**) than the centerline of the first axle when the roller assembly carrier is in the first predetermined position. The notch(es) **64** in the arm member(s) **56** of the carriage **44** are provided to permit the roller assembly carrier to be able to rotate between a predetermined first position and a predetermined second position. A torsion spring can be mounted to the carriage **44** and roller assembly carrier to bias the roller assembly carrier toward the first predetermined position. Exemplary further details of the roller assembly are described in the incorporated '657 reference.

As generally described previously with regards to the motor **32** and flywheel **34**, actuation of the drive actuator **36** causes the roller assembly to translate toward (e.g., in a generally downward direction, as indicated the arrow in FIG. **11**) and engage the driver **26** to initiate driving engagement between the driver **26** and the flywheel **34**, and thus move the driver **26** into a drive channel or barrel **66** of the nosepiece assembly **18** that has a lead fastener therein.

The drive actuator **36** may be an electro-mechanical actuator such as a linear actuator. In accordance with one embodiment, the drive actuator **36** is a solenoid **92** that includes a body **93**, a plunger **94** in the form of a shaft which is movable relative to the body **93** along an actuation axis **95**, and a plunger spring **96** that biases the plunger **94** into an extended position. While the plunger spring **96** is illustrated in FIG. **11** as being received in the body **93**, it will be appreciated that in the alternative the plunger spring **96** can be received about the plunger **94** between a feature on the plunger **94** and the plunger body **93** or between a feature on the plunger **94** and another part adjacent the body **93**. The body **93** may include a housing **98** and a coil assembly **99** therein that can be electrically coupled to the control unit **38** (see, e.g., schematic representation of electrical connection of drive actuator **36** with the control module, as shown in FIG. **15**). The body **93** may be fixedly coupled to the carriage **44** in a snap-fit manner, in accordance with an embodiment. The housing **98** may be sized to engage the arm members **56** such that abutment of the housing **98** against the arm members **56** limits movement of the body **93** relative to the arm members **56** when the coil assembly **99** is energized and the plunger **94** is being drawn into the body **93**. The plunger **94** may include a through-hole for receipt of a pin **100** which is used to pivotally couple the follower arm **48** and the plunger **94**. Accordingly the actuator slots **58** (shown in FIG. **12**), which may be disposed generally parallel to the actuation axis **95**, may guide and support the end of the plunger **94** to which the follower arm **48** is coupled.

The follower arm **48**, as shown for example, in FIG. **11**, may include a central arm member **76**, that has a non-linear profile. The central arm member **76** is configured to pivot and move via pin **100** connecting it to the plunger **94** of the solenoid **92**. As described below, when the plunger **94** moves (e.g., towards the left in FIG. **11**), the central arm member **76** of the follower arm **48** is pulled and pivotable as the non-linear profile moves within the housing, in a general direction along or relative to the axis **95**, and with respect to the roller assembly **40**. The follower arm **48** is configured to contact the roller assembly **40** (and its carrier) and push or displace the roller assembly **40** in a direction toward the driver **26**.

The driver **26** may be provided in the form of a driver blade that is configured for translational movement within a drive channel along a drive axis **118** to move within the drive channel/barrel **66** and drive the lead fastener into a workpiece. The driver **26** may be made of any number of materials, including, but not limited to, aluminum, nickel, steel, stainless steel, and/or combinations thereof.

FIGS. **11** and **12** illustrate the tool **10** in a state prior to activation of the solenoid **92**/drive actuator **36**. The plunger **94** of the solenoid **92** is located in an extended position (i.e., to the right in FIG. **11**) and the follower arm **48** is biased upwardly (as viewed in the figure) in a direction away from the flywheel **34** and the driver **26**. As shown in FIG. **11**, the follower arm **48** and roller assembly **40** are in their respective home positions. The driver is also in a home position (or able to return to such a position, after driving the fastener). Also shown is that when the follower arm **48** and the roller assembly **40** are in their home positions, the solenoid **92** is not actuated and a spring (e.g., torsion spring) is used to bias the roller assembly **40** away from the flywheel **34**.

Although not illustrated, per the previous detailed explanation, it should be understood that when the solenoid **92**/drive actuator **36** has been actuated, the plunger **94** is pulled in a second direction (opposite to the first direction, i.e., towards the left in FIG. **11**) into the body **93**. Movement of the plunger **94** in the second direction displaces and pulls the follower arm **48** toward the body **93**, which causes the follower arm **48** to act as a wedge against the first roller **42** to drive the roller assembly **40** toward the driver **26** (downwardly as viewed in the figure). The follower arm **48** transfers the force and displacement of the plunger **94** in a direction orthogonal to the axis **95** of the solenoid. The second roller **50** is thus moved into contact with the driver **26** and may further force or drive the driver **26** into driving engagement with the flywheel **34** as the roller assembly **40** is moved.

After the driver **26** has translated and fired the fastener from the nosepiece assembly, the return mechanism **30** may be employed to return the driver **26** to its starting position. When the driver **26** has been returned, the solenoid **92** may be deactivated to permit the plunger spring **96** to move the plunger **94** back towards its home position. Movement of the plunger **94** in this manner thus allows the follower arm **48** to move and in cause/allow the roller assembly **40** to travel away from the driver **26**.

A feed assembly **110** (see FIG. **9**) (or feed mechanism) is associated with the magazine assembly **14** and is configured to advance the fasteners contained therein in a feed direction to present a lead fastener into the nosepiece assembly **18**. The feed assembly **110** has feed actuator **148** (e.g., see FIG. **1**) configured to move said lead fastener into the nosepiece assembly **18**. Generally, in accordance with an embodiment, the feed assembly **110** may include a biasing spring and a feed rod configured to move the lead fastener (from a set of collated fasteners contained in canister **200**) into the nosepiece assembly **18**. The biasing spring may bias the feed rod into a first position, and the feed actuator **148** may be configured to move (i.e., reciprocate) the feed rod to a second position, against a biasing force of the biasing spring, for moving said lead fastener into the nosepiece assembly **18**. In an embodiment, features of the feed assembly may include those of the incorporated '521 reference.

Like the drive actuator **36**, the feed actuator **148** may be an electro-mechanical actuator such as a linear actuator. The feed actuator **148** may be in the form of a solenoid **150** (see FIG. **9**), in accordance with an embodiment, that includes a body **151**, a plunger **152** in the form of a shaft which is movable relative to the body **151** along an actuation axis **153**, and a plunger spring **154** that biases the plunger **152** into an extended position, e.g., towards the nosepiece assembly **18**. While the plunger spring **154** is illustrated as being outside the body **151**, it will be appreciated that in the alternative, the plunger spring **154** may be received about the plunger **94** within part of the plunger body **151**, for example. The body **151** may include a housing **156** and a coil assembly **155** that can be electrically coupled to the control module **38** (see, e.g., schematic representation of electrical connection of feed actuator **148** with the control module, as shown in FIG. **15**). The body **151** may be coupled to the feed mechanism **110**, below the nosepiece assembly **18** and above the magazine **14**/canister **200**, in accordance with an embodiment. The plunger **152** may have an abutment structure associated therewith such that the plunger spring **154** extends between a top portion of the housing **156** (or body **151**) and the abutment structure. Also, the plunger **152** may include a through-hole **158** at an upper portion thereof, e.g., for receipt of a spring (or portion thereof, see, e.g., FIG. **5**), or pin. The housing **156** may be sized such that the plunger **152** is configured to move relatively therein and compress the plunger spring **154** when the coil assembly **155** is energized. In one embodiment, the plunger **152** may be drawn into the body **151**. Accordingly, activation of the coil assembly **155** results in movement (e.g., pulling relatively downward) of the shaft of the plunger against the force of spring **154** to allow a nail to be loaded. When the feed actuator **148** is deactivated, the spring **154** biases the shaft of the plunger **154** upward and allows the nail to be loaded into a chamber (or drive channel) that is along the path of the driver **26**.

In accordance with an embodiment, in the tool **10**, the drive actuator **36** is positioned on a first axis **95**, wherein the feed actuator **148** is positioned on a second axis **153**. As evidenced by FIGS. **11** and **12**, these first and second axes **95** and **153** are positioned at a non-perpendicular angle relative to one another. In one embodiment, the first or actuation axis **95** is positioned such that the axis **95** is parallel to the drive axis **118**. In another embodiment, the second or actuation axis **153** is parallel to the feed direction (i.e., the axis extending at an angle from near a bottom of the tool **10** to the nosepiece assembly **18**; see axis **146** in FIG. **12**). In yet another embodiment, the first or actuation axis **95** is positioned such that the axis **95** is parallel to the drive axis **118**, and the second or actuation axis **153** is parallel to the feed direction (i.e., axis **146** in FIG. **12**).

In still yet another embodiment, the drive axis **95** of the drive actuator **36** is provided in a first plane and an axis **153** of the feed actuator **148** defining the feed direction is provided in a second plane, the first plane being different from said second plane.

While the exemplary illustrated embodiments are described as using solenoids **92**, **150** as the electro-mechanical actuators, other forms of actuators may be used, for example, an electric motor, a single dual-action solenoid, a multi-stage solenoid, a solenoid in conjunction with a mechanical biasing element, such as a spring, a linear motion machine, or any combination thereof.

The drive actuator **36** (e.g., solenoid **92**) and the feed actuator **148** (e.g., solenoid **150**) are connected to the control module **38** (or controller) via control lines. The control module **38** and circuitry may be provided at the back end **52** of the housing assembly **12**, for example. Control module is programmed to provide power and/or control signals (e.g., electric pulses) over control lines the actuators **36** and **148**. The control module **38** may receive input from the trigger **20**, which affects movement of the driver **26** and feed rod to load fasteners in the nosepiece assembly **18** of the tool **10**. The control module **38** may be provided in the form of a microprocessor and one or more circuit boards, for example, including relay module and one or more MOSFETs. The control module **38** also communicates with the motor **32**. Upon receiving a signal from the trigger switch **68** and a safety mechanism (contact trip assembly **21**) and its switch, the control module **38** may be connected to the battery **22** to receive power therefrom and the drive actuator **36** may be activated. The control module **38** may signal the motor **32** to energize or activate for a predetermined amount of time (e.g., by applying voltage to the motor **32**) before activating the drive actuator **36**.

As is understood by one of ordinary skill in the art, the control module **38** is configured for outputting a driving control signal to the drive system **16** and for outputting a motor signal to control an operation of the motor **32** via selectively energizing coils (of the stator) of a plurality of phases of the motor **32**. A position detector may be associated with the motor **32** to output a position signal corresponding to the position of a rotor (at one place) of the motor. The position detector may be a magnetic sensor such as a hall sensor/element or a hall IC, for example, and a hall signal may be output as the position signal. The position signal output from the position detector is input to the control module **38**. In an embodiment, the control module **38** may include an inverter circuit design to output a control signal to the motor **32**, to control the rotation of the motor **32**. In one embodiment, the inverter circuit has six switching elements for supplying driving current to the respective coils of the motor **32**, wherein three of the switching elements are high-side switching elements and three of the switching elements are low-side switching elements.

In accordance with an embodiment, the control module **38** may include the control unit and/or features of said unit as disclosed in U.S. Pat. No. 10,693,344, which is incorporated by reference herein in its entirety.

The control module **38** is configured to implement a firing sequence for driving each lead fastener into the workpiece (using the driver **26**) and feeding the lead fastener into the nosepiece assembly **18**. In particular, the control module **38** is designed to control the timing for actuating/activating the drive actuator **36** and the feed actuator **148**, and, thus, the timing for feeding an electric pulse to each of the drive actuator **36** and the feed actuator, for a firing sequence (i.e., driving a fastener and (re)loading a lead fastener into the nosepiece assembly **18** for the next drive). That is, the firing sequence may include sending a first electric pulse to the drive actuator **36** and a second electric pulse to the feed actuator **148**, in accordance with an embodiment.

In an embodiment, the firing sequence implemented by the control module **38** results in an excitation pattern that includes selectively deactivating energization (power) to the motor in order activate the drive actuator **36** and the feed actuator **148**. In one embodiment, the control module **38** is configured to deenergize or deactivate energization the motor for at least a part of each electric pulse (at least a portion of the first electric pulse and at least a portion of the second electric pulse) sent to the drive actuator **36** and to the feed actuator **148**, in order to activate the drive actuator and the feed actuator. In one embodiment, the excitation pattern comprises a delay time interval between the electric pulses to the drive actuator **36** and the feed actuator **148**. In an embodiment, the control module **38** is configured to calculate timing in the excitation pattern for feeding the first electric pulse to the drive actuator and the second electric pulse to the feed actuator for activation thereof during the firing sequence, and calculate a delay time interval between the first and second electric pulses. FIG. **13** illustrates one exemplary embodiment illustrating such features. Specifically, FIG. **13** shows output waveforms provided as a result of signals from the control module **38** to the contact trip switch, motor **32**, drive actuator **36**, and feed actuator **148**. As previously mentioned, in an embodiment, the motor **32** may be initially energized or activated by the control module **38** before implementing a firing sequence (see, e.g., voltage signal (e.g. 5 V) for motor). A substantially constant signal (e.g., 5 V) may be supplied to the motor **32** for energization thereof when power is turned on for the tool. A voltage (e.g., 5 V) signal is provided to the contact trip switch. Upon tripping of the switch, a time delay is implemented before de-energizing the motor **32** and providing a pulse PTO (e.g., a current of 20 A) to the drive actuator. While the drive actuator **36** (and thus the drive system **16**) is energized, power to the motor is limited or cut off. In accordance with an embodiment, the signal to the motor may be cut off shortly after the pulse PTO signal is sent to the drive actuator. As understood by a person skilled in the art, as a result of the cut off power supply, the coils of the motor **32** are thus not further energized and the rotor rotation winds down. As shown in FIG. **13**, in one embodiment, a time delay of approximately 20+/−5 milliseconds is implemented before the control module **38** deploys a pulse FED (e.g., a current of 20 A) to the feed actuator **148**. The power signal to the motor **32** may be optionally cut off during this pulse FED. As a result of the pulse FED, the plunger **154** may be moved downward against the force of spring **154** to allow a nail to be loaded. When the feed actuator **148** is deactivated, the spring **154** biases the shaft of the plunger **154** upward and allows the next nail to be loaded into a chamber (or drive channel) for the driver **26**. Upon completion of the pulse FED, the motor **32** may be re-energized. In an embodiment, a second time delay may be implemented by the control module **38** after the pulse FED and before energizing the motor **32**. In one embodiment, the second time delay is approximately 50+/−5 milliseconds (ms).

In an embodiment, the entire timing of the sequence from the time of activation of the contact switch (via trigger) to the time that the power to the motor is re-activated or re-energized (after the first and second electric pulses to the drive actuator and the feed actuator) is approximately 225 milliseconds (ms) (+/−5 ms).

According to an embodiment, the control module **38** may be configured to activate or energize the motor during the time interval between the first and second electric pulses to the drive actuator **36** and the feed actuator **148**. That is, rather than limiting or stopping the excitation signal to the motor during this time delay, at least some voltage is directed to the motor **32** until the pulse to the feed actuator **148**. In an embodiment, the motor is activated for at least a portion of a time between the first electric pulse and the second electric pulse (to the drive actuator and the feed actuator, respectively). FIG. **14** illustrates an example of such features, wherein the motor receives a voltage signal between the first pulse PTO (the first electric pulse to the drive actuator **36**) and the second pulse FED (equivalent to the pulse FED, i.e., the second electric pulse to the feed actuator **138**). As a result, the rotational speed of the motor does not reduce as much during the pulses, and, therefore, the timing between the first and second electric pulses may be reduced. Furthermore, as a result of this reduced time delay between the pulses and by reverting power back to the motor and energizing the motor **32** during this delay, it has been observed that the number of fasteners or nails driven per second may be increased, e.g., from three nails per second (**3** nail/sec) to four nails per second (**4** nails/sec). This is a result of the energy (inertia) maintained in between the pulses of the sequence.

In particular, FIG. **14** shows output waveforms provided as a result of signals from the control module **38** to the motor **32**, drive actuator **36**, and feed actuator **148**. As previously mentioned, in an embodiment, the motor **32** may be initially energized or activated by the control module **38** before implementing a firing sequence (see, e.g., voltage signal (e.g. 5 V) for motor). In the example illustrated, a larger amount of power may be supplied to the motor **32** for energization thereof when power is turned on for the tool. In an embodiment, activation of a contact switch may also provide additional power to the motor (e.g., anticipating that the trigger **20** will soon be pulled, and thus that driving of a nail will soon commence.) After tripping of the switch, a pulse PTO (e.g., a current of 20 A) to the drive actuator is implemented by the control module **38** and the signal to the motor **32** is cut-off after a time period. In accordance with an embodiment, the signal to the motor may be cut off approximately 10+/−5 milliseconds after the pulse PTO signal is sent to the drive actuator. While the drive actuator **36** (and thus the drive system **16**), is energized, power to the motor is limited or cut off. In one embodiment, a time delay of approximately 100+/−10 milliseconds is implemented before the control module **38** deploys a pulse FED (e.g., a current of 20 A) to the feed actuator **148**. However, during this time delay, the control module **38** is configured to energize the motor **32** by sending a signal thereto, as shown. The pulse FED may then be sent to the feed actuator **148**, and the power signal to the motor **32** is cut off during this pulse. The feed actuator **148** may then load a next nail to be driven, as explained above, and then is deactivated. Upon completion of the pulse FED, the motor **32** may be re-energized.

Accordingly, the control module **38** is configured to perform a method that includes deactivating power to the motor; activating the drive actuator to thereby cause the translational movement of the driver thus drive the lead fastener into the workpiece; and activating the feed actuator to feed the lead fastener into the nosepiece assembly. In one embodiment, the motor is deactivated or deenergized for at least a part of each pulse sent to activate the drive actuator and the feed actuator. For example, as illustrated in FIG. **13** and FIG. **14**, the power to the motor may be cut off or deactivated on or about (e.g., shortly after) a time for applying the PTO pulse to the drive actuator. In an embodiment, deactivating the power to the motor is performed before activating the drive actuator or within a predefined time period after activating the drive actuator. In an embodiment, deactivation may be a time period of approximately 0 (zero) to approximately 20 milliseconds (ms) (both inclusive and both +/−5 ms) from the time the pulse signal is sent to the drive actuator. In one embodiment, such as shown in FIG. **14**, the power to the motor is deactivated approximately 0 to 10 ms after the pulse is sent to the drive actuator.

In an embodiment, the method employed by the control module **38** may also include deactivating the drive actuator and providing a time delay before activating the feed actuator. In an embodiment, the time delay/period between the first pulse (PTO pulse to the drive actuator) and the second pulse (FED pulse to the feed actuator) is approximately 100+/−10 milliseconds (ms).

Further, the method employed by the control module **38** may include activating power to the motor during the time delay.

The control module **38** is also configured to deactivate the feed actuator. In an embodiment, the power to the motor may be activated in a period of time after deactivation of the second pulse. In one embodiment, the time period is approximately 0 (zero) to approximately 50 milliseconds (both inclusive, and both +/−5 ms) after the second pulse is deactivated.

As understood by one of ordinary skill in the art, the timing sequence may, according to one embodiment, be based on a pre-programmed sequence that is based on time intervals known for performing each of the actions (e.g., driving the driver **26**, feeding the nail). In one embodiment, one or more sensor may be used in the tool to communicate with the controller regarding the firing cycle and/or status (e.g., speed) of the motor.

For the sake of completeness, other features may be provided on the tool **10**. As shown in FIGS. **1** and **7**, for example, a stall release lever **140** may be provided on an outside of the housing assembly **12** to address a stall condition or problem with regards to firing the tool **10**, e.g., a jam. The stall release lever **140** includes a lever arm **142**, a spool, and a flange. The spool and the flange rotate with the lever arm. The stall release lever may be activated by a user in an instance when a drive cycle is not completed. For example, when attempting to drive a nail into a hard material and insufficient power is available to fully sink the nail, the tool **10** may stall or jam. Other cases for an incomplete drive cycle may include operational anomalies such as improper nail loading, non-conforming nails being used, or worn or broken components in the tool. In operation, when a stall or jam occurs, the operator may rotate the lever arm in a counter clockwise direction to release the load on the activation system, thereby moving the roller assembly **40** away from driver **26**. Thus, the components in the tool are able to return to their respective home positions.

As is generally known, one or more, or all, of the switches mentioned herein may be microswitches.

Accordingly, an exemplary operation of the tool **10** is illustrated in some of the method steps as shown in a method **180** according to FIG. **16**. Operation of the tool **10** may include an operator or user positioning the nosepiece assembly **18** in position on a workpiece. As the operator places bias on the tool **10** towards the workpiece, the contact trip assembly **21** is moved or actuated, placing the tool **10** in an active state, waiting for the trigger **20** to be pulled or depressed. The control module **38** may send a signal to the motor **32** to energize it after the contact trip switch is tripped. When the trigger **20** is pulled by the operator, the trigger switch **68** is closed, initiating the control module **38** to activate the drive actuator **36**, and shown in step **182**, and thus drive a fastener. Power to the motor is limited and/or deactivated during the signals (electric pulses) to the drive actuator **36**, as noted at step **182**, which may be before or shortly after step **184**. Accordingly, the driver **26** drives the lead fastener into the workpiece. Then, the drive actuator is deactivated by the controller after the fastener is driven into a workpiece, as shown at step **186**. A time delay is then initiated, as shown at step **188**. The motor **32** may optionally receive power after the deactivation of the drive actuator **36**, during the time delay, as shown at step **190**. Then, after the time delay period has passed, the power signal to the motor **32** is again cut off and the control module **38** activates the feed actuator **148**, as shown in at step **190**. As a result, the plunger **154** may be moved to load the force of spring **154** and to allow a nail to be loaded. Thereafter, the spring **154** biases the shaft of the plunger **154** back to its home position and loads the next fastener to be driven by the driver **26**. Return of the feed actuator **148** and deployment of the next fastener into the drive channel is a result of the feed actuator **148** being deactivated, as shown at step **192**, and then the motor may be re-energized for the next firing sequence. In accordance with an embodiment, the rotation of the motor **32** is deactivated by the controller for at least a part of the signals (electric pulses) sent to activate the drive actuator (step **184**) and the feed actuator (step **190**).

Reference throughout the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases "in one embodiment" or "in an embodiment" in various places throughout the specification is not necessarily referring to the same embodiment, or different embodiments. Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments. Further, it is intended that embodiments of the disclosed subject matter cover modifications and variations thereof.

While aspects of this disclosure are described herein and illustrated in the accompanying drawings in the context of fastening tool, those of ordinary skill in the art will appreciate that the invention, in its broadest aspects, has further applicability.

It will be appreciated that the above description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. While specific examples have been described in the specification and illustrated in the drawings, it will be understood by those of ordinary skill in the art that various changes may be made, and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. Furthermore, the mixing and matching of features, elements and/or functions between various examples is expressly contemplated herein, even if not specifically shown or described, so that one of ordinary skill in the art would appreciate from this disclosure that features, elements and/or functions of one example may be incorporated into another example as appropriate, unless described otherwise, above. Moreover, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular examples illustrated by the drawings and described in the specification as the best mode presently contemplated for carrying out the teachings of the present disclosure, but that the scope of the present disclosure will include any embodiments falling within the foregoing description.

What is claimed is:

1. A tool comprising:

a housing having a nosepiece assembly;

a motor;

a drive actuator;

a magazine assembly configured to hold a plurality of fasteners;

a feed assembly associated with the magazine assembly configured to advance each of the plurality of fasteners in a feed direction to present a lead fastener into the nosepiece assembly, the feed assembly comprising a feed actuator configured to move said lead fastener into the nosepiece assembly;

a driver provided in the housing and configured for translational movement within a drive channel along a drive axis to drive the lead fastener into a workpiece;

a drive system, associated with the drive actuator, configured to selectively drive the driver along the drive axis; and

a controller connected to the feed actuator and the drive actuator to implement a firing sequence for driving each lead fastener into the workpiece using the driver and feeding the lead fastener into the nosepiece assembly, wherein the firing sequence comprises a first electric pulse to the drive actuator and a second electric pulse to the feed actuator, and wherein the motor is activated for at least a portion of a time after the first electric pulse and before the second electric pulse, but the motor is not activated for at least a portion of a time during the first electric pulse and at least a portion of a time during the second electric pulse.

2. The tool according to claim **1**, wherein the controller is configured to calculate timing in an excitation pattern for feeding the first electric pulse to the drive actuator and the second electric pulse to the feed actuator for activation thereof during the firing sequence, and calculate a delay time interval between the first and second electric pulses.

3. The tool according to claim **2**, wherein the motor is deenergized for at least a part of each of the first electric pulse to the drive actuator and the second electric pulse to the feed actuator.

4. The tool according to claim **1**, wherein the drive system further comprises a flywheel, wherein said motor is configured to drive the flywheel, and wherein the drive actuator is configured to move the driver into engagement with the flywheel such that energy is transferred from the flywheel to the driver and cause the driver to move translationally.

5. The tool according to claim **4**, wherein the drive system further comprises an arm and a roller, the arm being spring biased by a spring towards a first position, the drive actuator being configured to press against the spring to move the arm into a second position such that the arm moves the roller to push the driver into engagement with the flywheel to cause the translational movement of the driver.

6. The tool according to claim **1**, wherein the feed assembly further comprises a biasing spring and a feed rod configured to move the lead fastener into the nosepiece assembly, the biasing spring configured to bias the feed rod into a first position, and the feed actuator being configured to move the feed rod to a second position, against a biasing force of the biasing spring, for moving said lead fastener into the nosepiece assembly.

7. The tool according to claim **1**, wherein the drive actuator is positioned on a first axis, wherein the feed actuator is positioned on a second axis, and wherein said first axis and said second axis are positioned at a non-perpendicular angle relative to one another.

8. The tool according to claim **7**, wherein the first axis is parallel to the drive axis and wherein the second axis is parallel to the feed direction.

9. The tool according to claim **1**, wherein the drive axis is provided in a first plane and an axis of the feed actuator defining the feed direction is provided in a second plane, said first plane being different from said second plane.

10. The tool according to claim **1**, wherein the drive actuator and/or the feed actuator comprises a solenoid.

11. A method for operating a tool according to claim **1**, the method comprising:

deactivating power to the motor;

activating the drive actuator to thereby cause the translational movement of the driver thus drive the lead fastener into the workpiece; and

activating the feed actuator to feed the lead fastener into the nosepiece assembly.

12. The method according to claim **11**, further comprising deactivating the drive actuator and providing a time delay before activating the feed actuator.

13. The method according to claim **12**, further comprising activating power to the motor during the time delay and deactivating the feed actuator.

14. The method according to claim **11**, wherein the deactivating power to the motor is performed before activating the drive actuator or within a predefined time period after activating the drive actuator.

15. The method according to claim **11**, wherein the motor is deactivated for at least a part of the first electric pulse and the second electric pulse sent to activate the drive actuator and the feed actuator.

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